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Worthington

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(54) **RAZOR SHARPENING SYSTEM**

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(73) Assignee: **Born Sharp, L.L.C.**, Santa Barbara, CA (US)

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Related U.S. Application Data

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(51) **Int. Cl.**
B24B 3/48 (2006.01)

(52) **U.S. Cl.**
USPC **451/45**; 451/58; 451/65; 451/163; 451/164; 451/371; 30/35; 76/81.7; 76/DIG. 9

(58) **Field of Classification Search**
USPC ..... 451/45, 57, 58, 65, 66, 163, 164, 169, 451/349, 367, 371, 463; 30/35, 36, 37, 38; 76/81.7, DIG. 9
See application file for complete search history.

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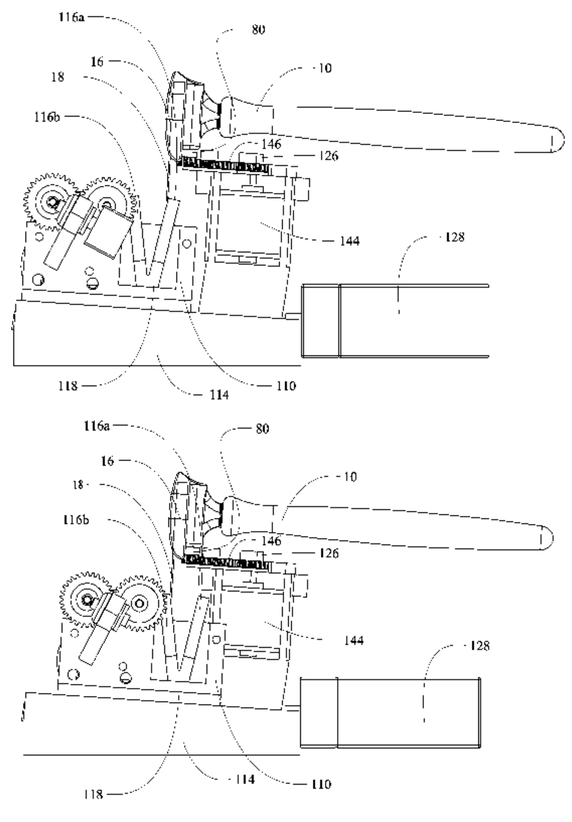
(74) *Attorney, Agent, or Firm* — Felix L. Fischer

(57) **ABSTRACT**

A self sharpening razor system includes a razor having a handle and a safety housing with a blade extendably received within the safety housing. An integrated sharpening system incorporates an armature receiving the razor and movable between a first position for attachment and extraction of the razor and a second position for sharpening of the blade. A sharpening mandrel is provided with sharpening surfaces for sharpening first and second sides of the blade. The sharpening mandrel is rotatable from to engage the first sharpening surface and second sharpening surface. The sharpening mandrel is laterally oscillated for sharpening of the blade. In alternative embodiments, sharpening is accomplished with reciprocating honing plates with available stropping wheels or integrated honing and stropping wheels with exposure adjustability and sharpness adjustability via honing time variance. A controller is provided for positioning of the armature and sharpening mandrel.

17 Claims, 27 Drawing Sheets



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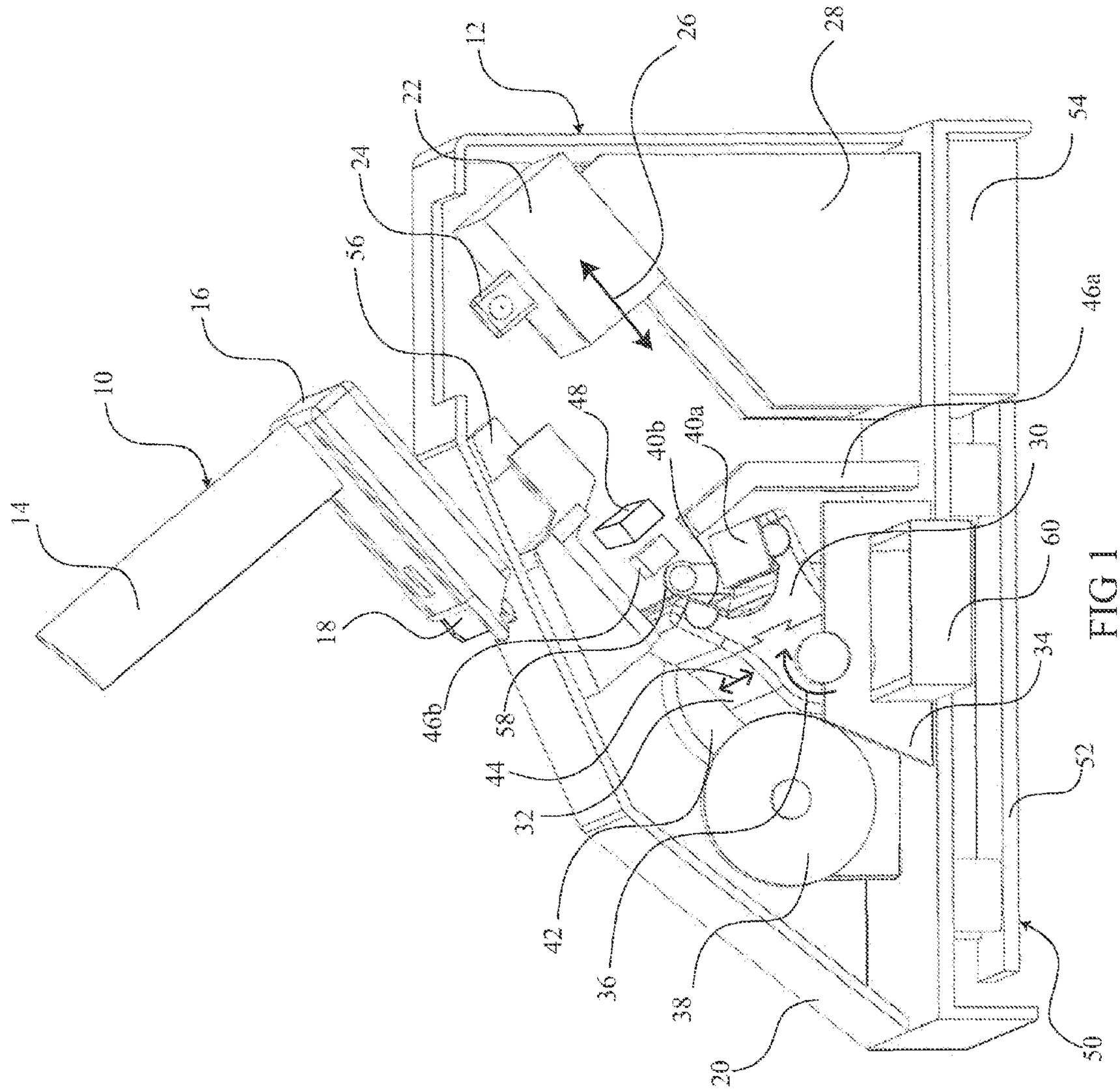
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FIG 1

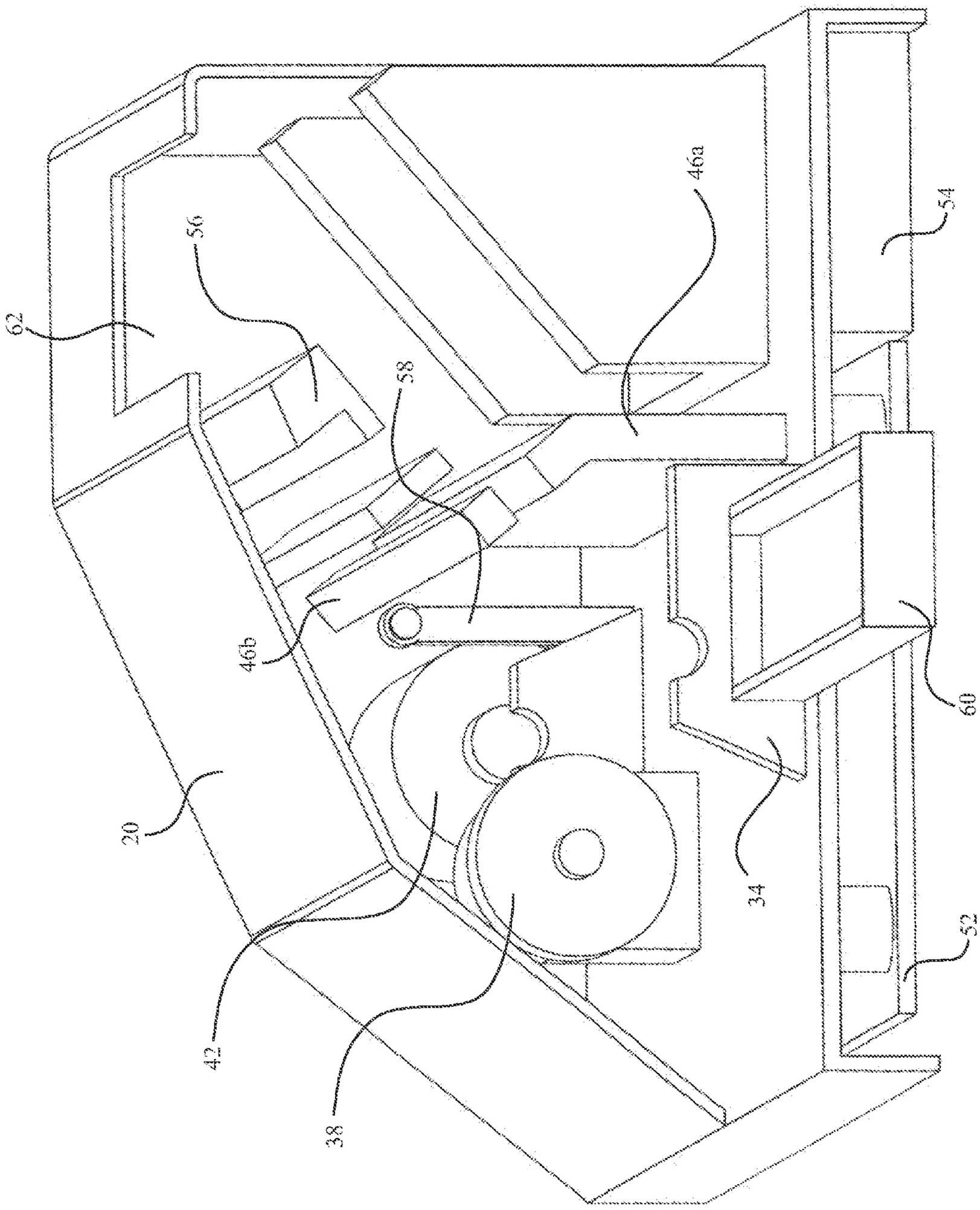


FIG 2

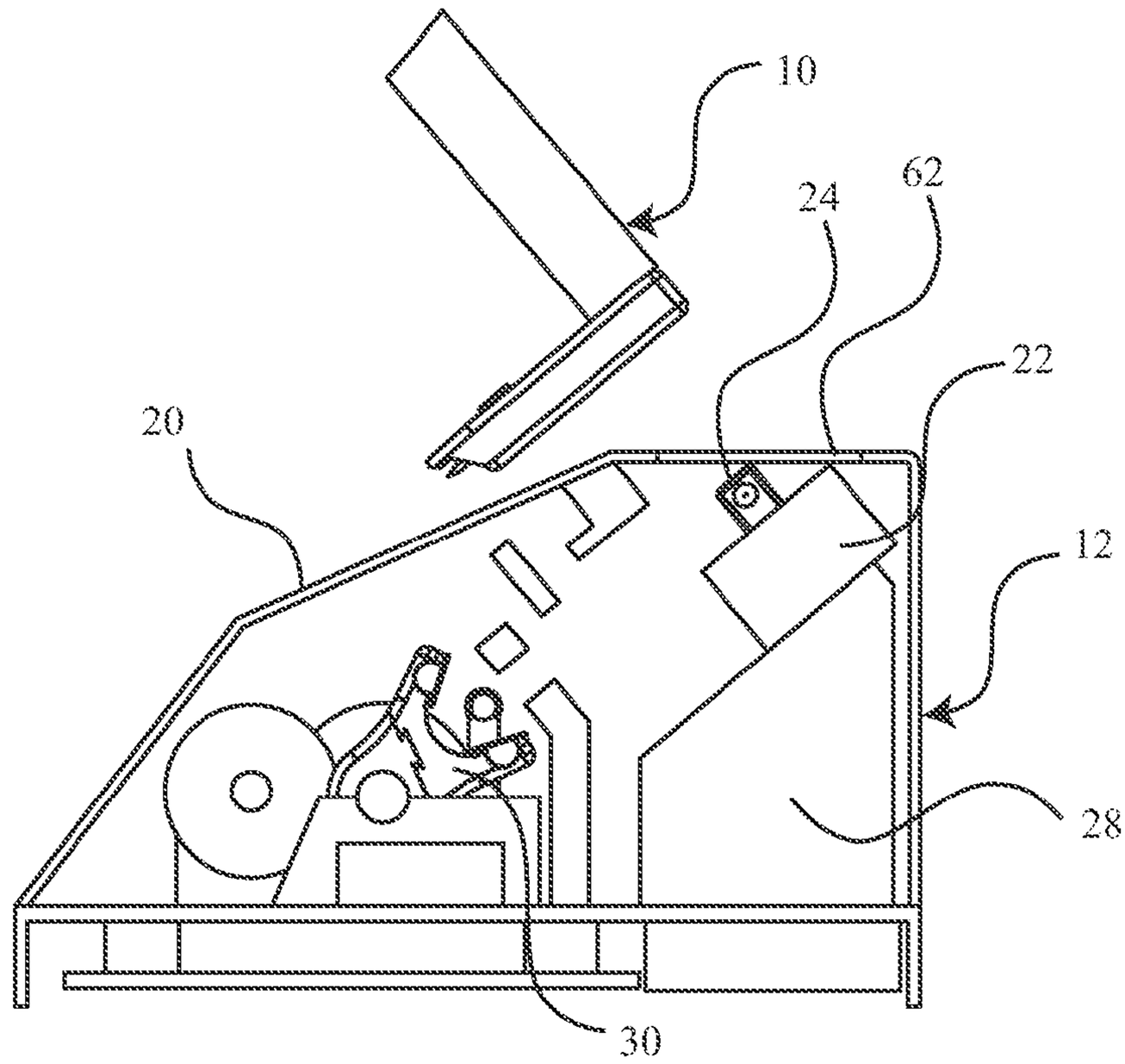


FIG 3A

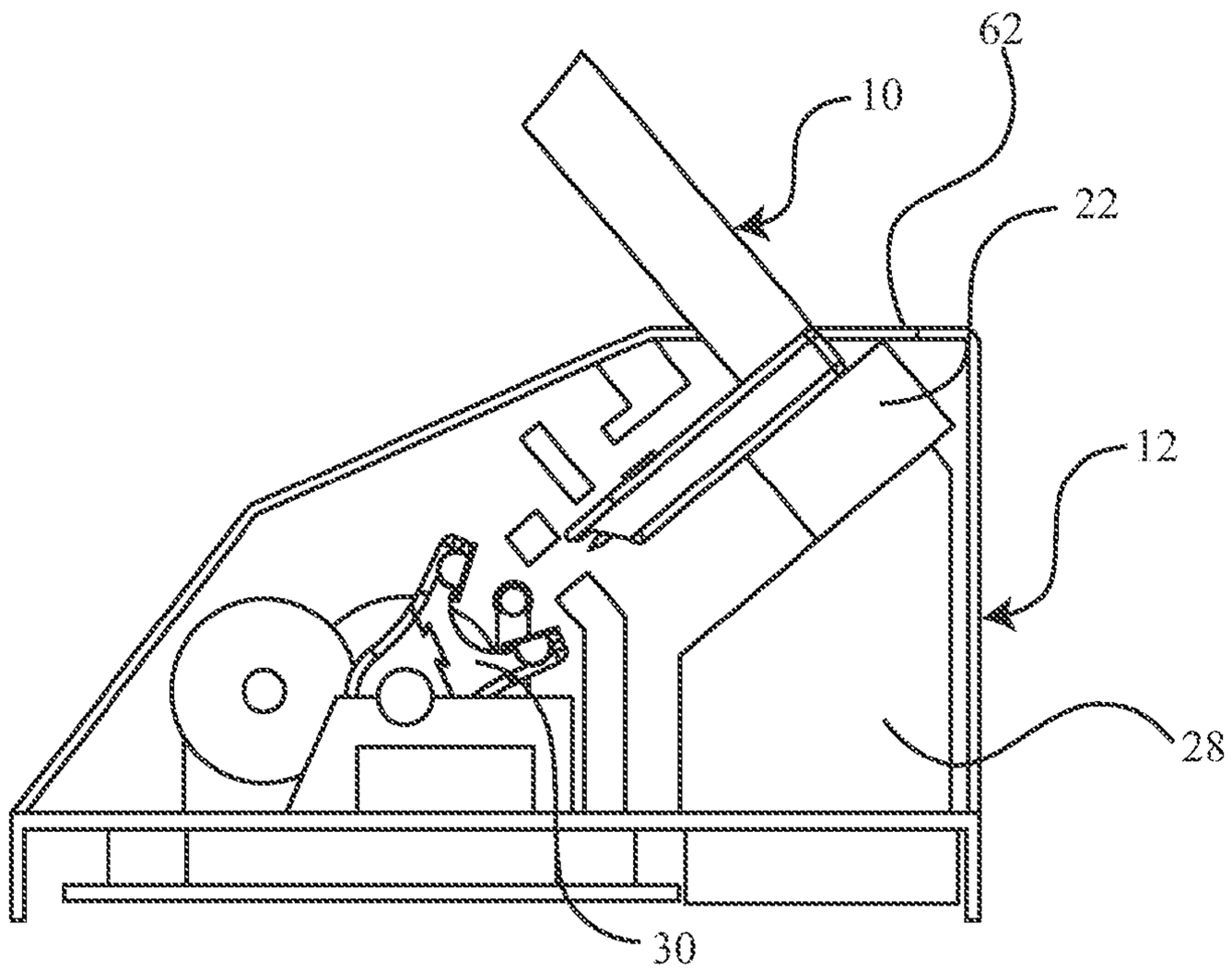


FIG 3B

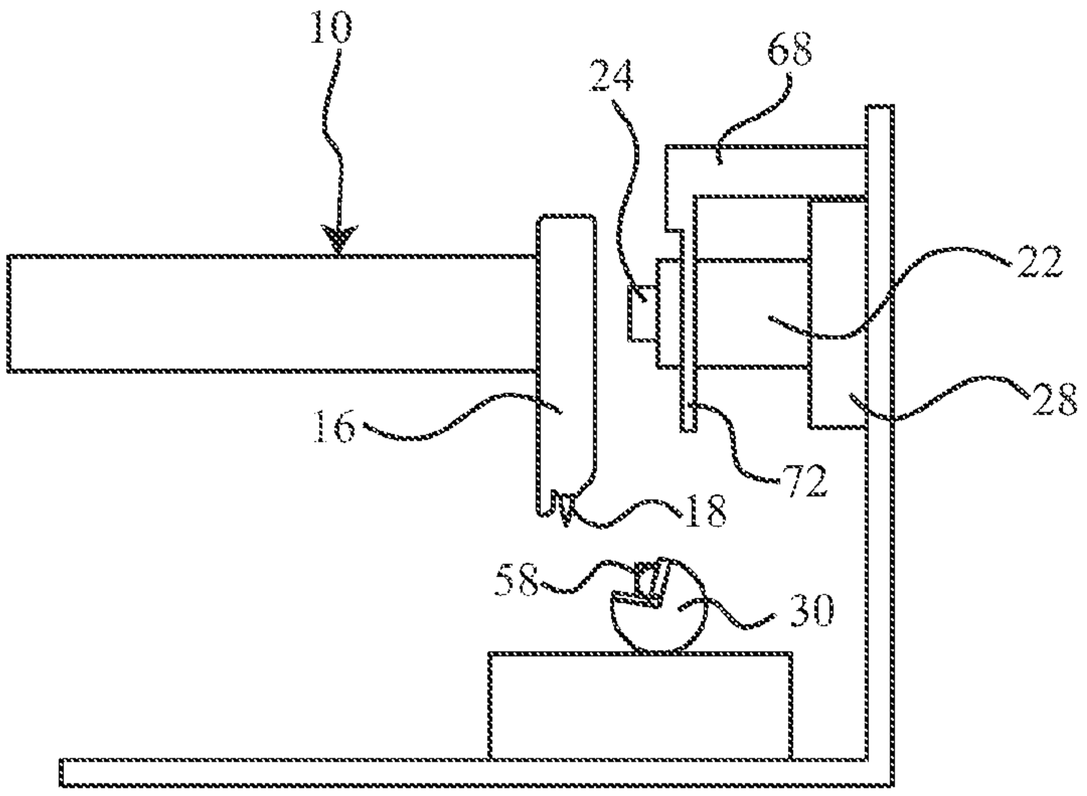


FIG 4A

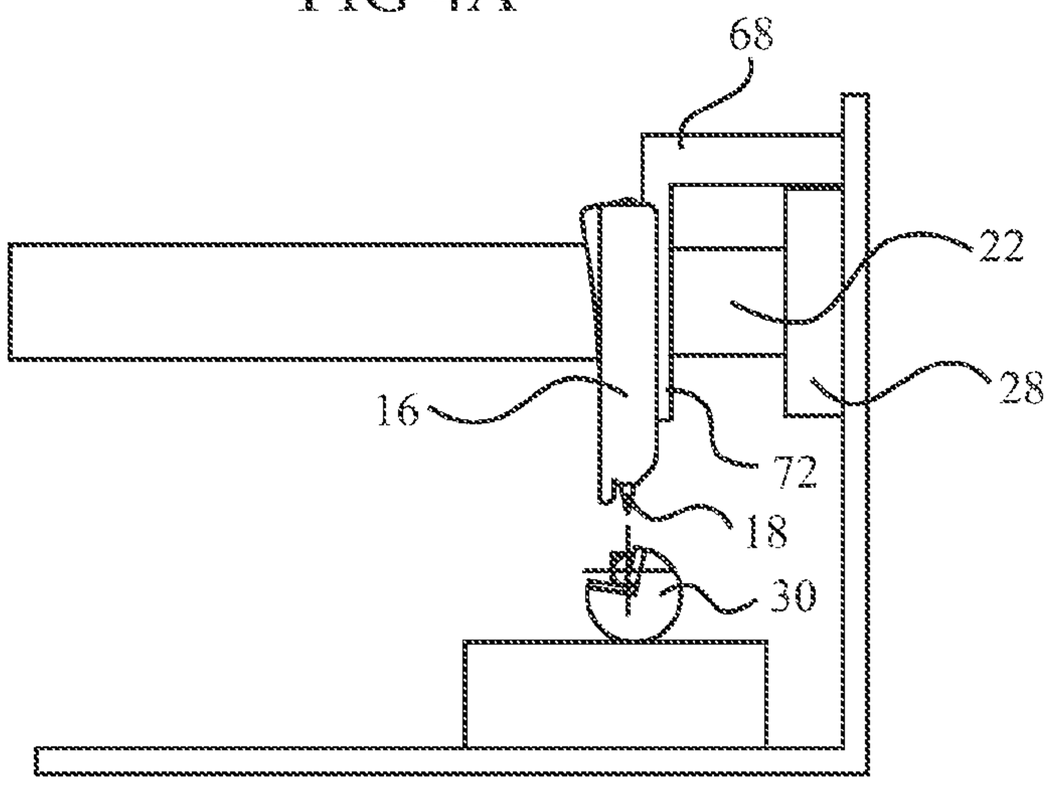


FIG 4B

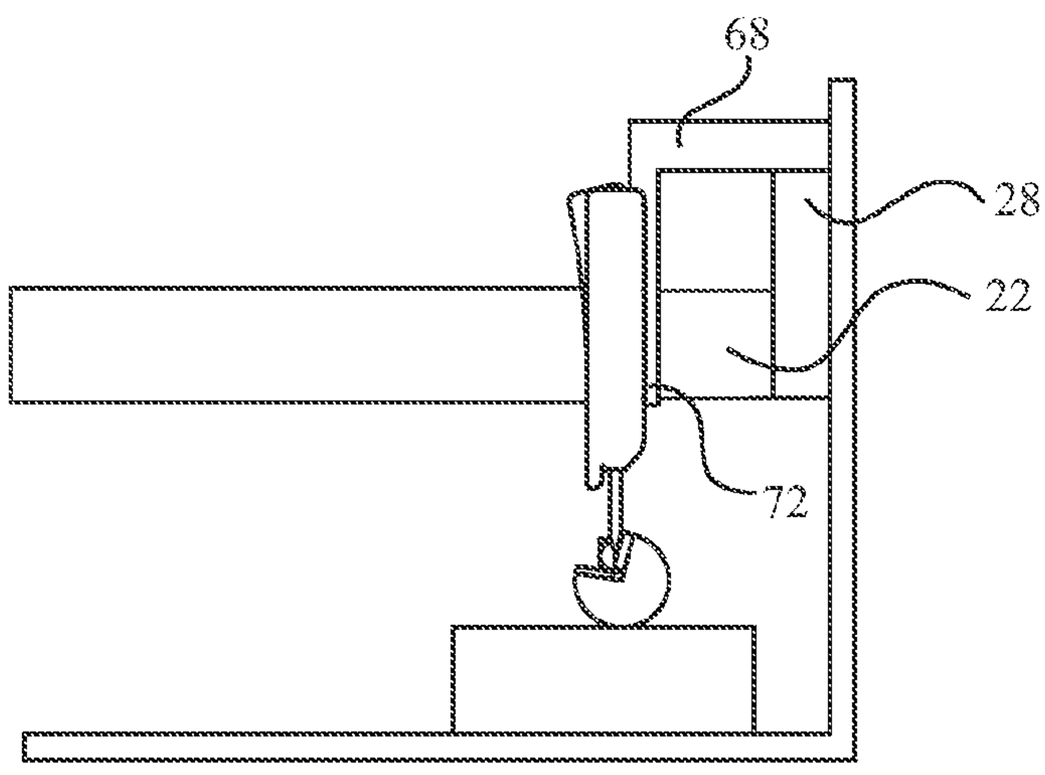


FIG 4C

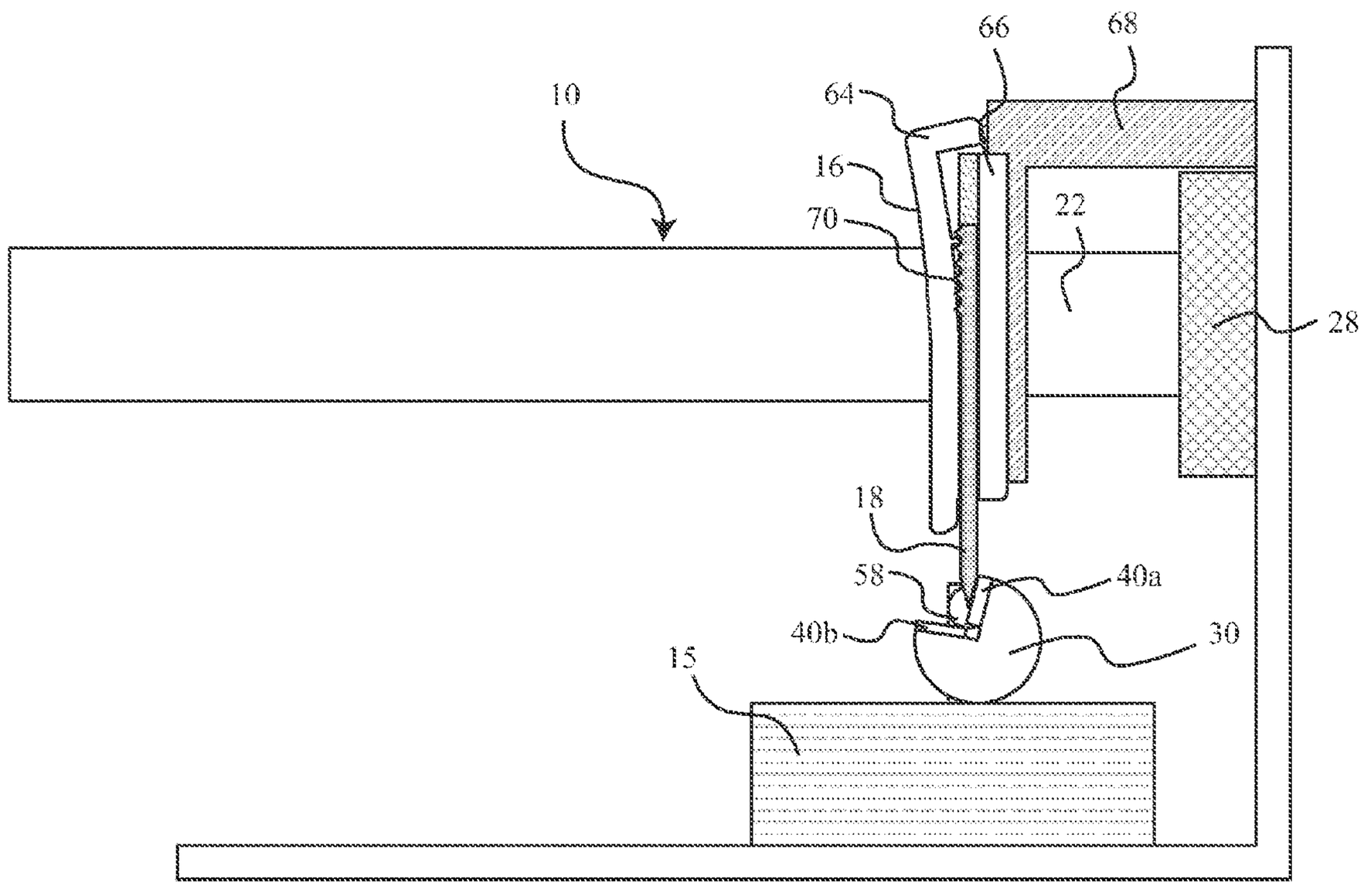


FIG 4D

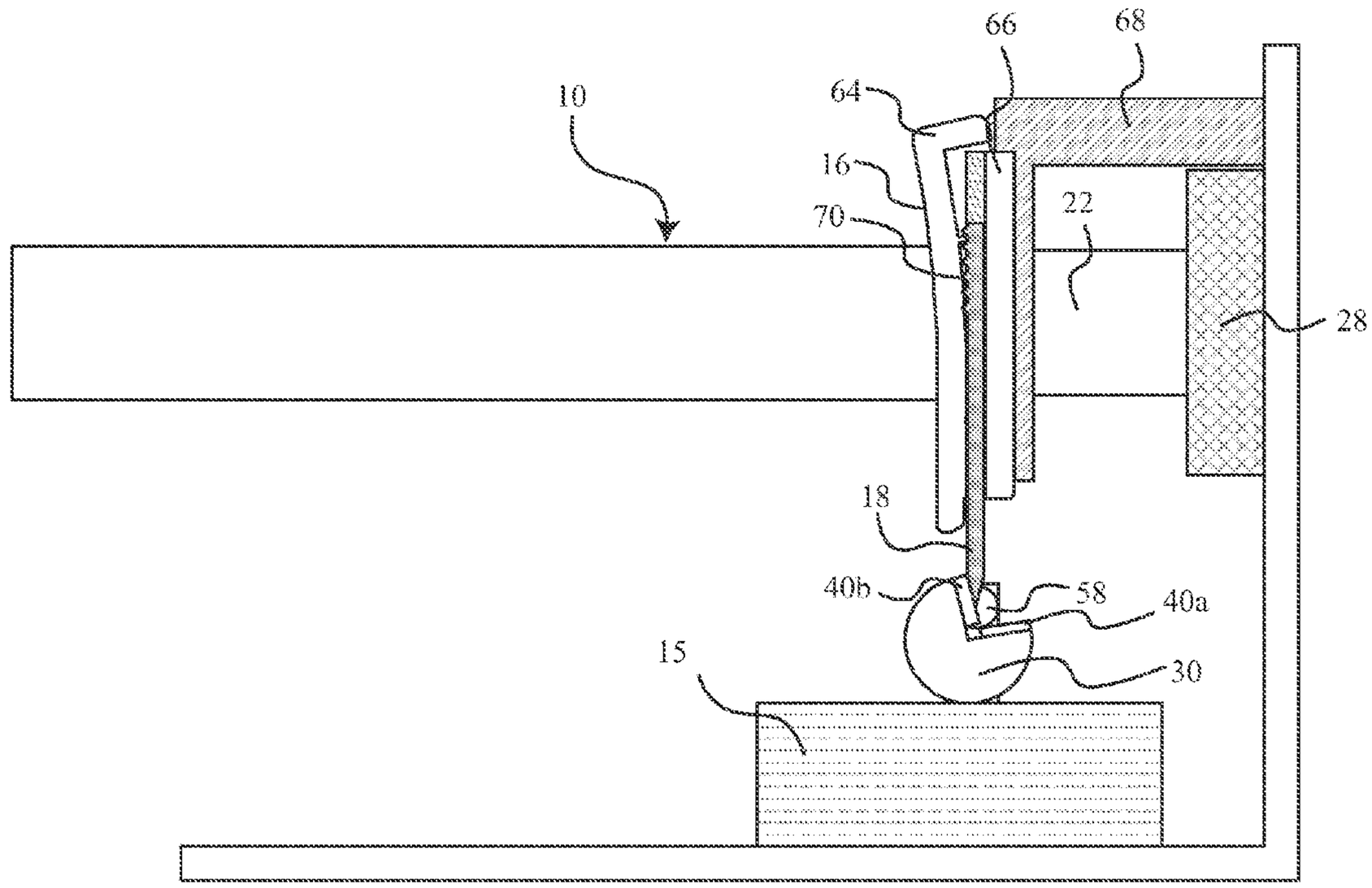


FIG 4E

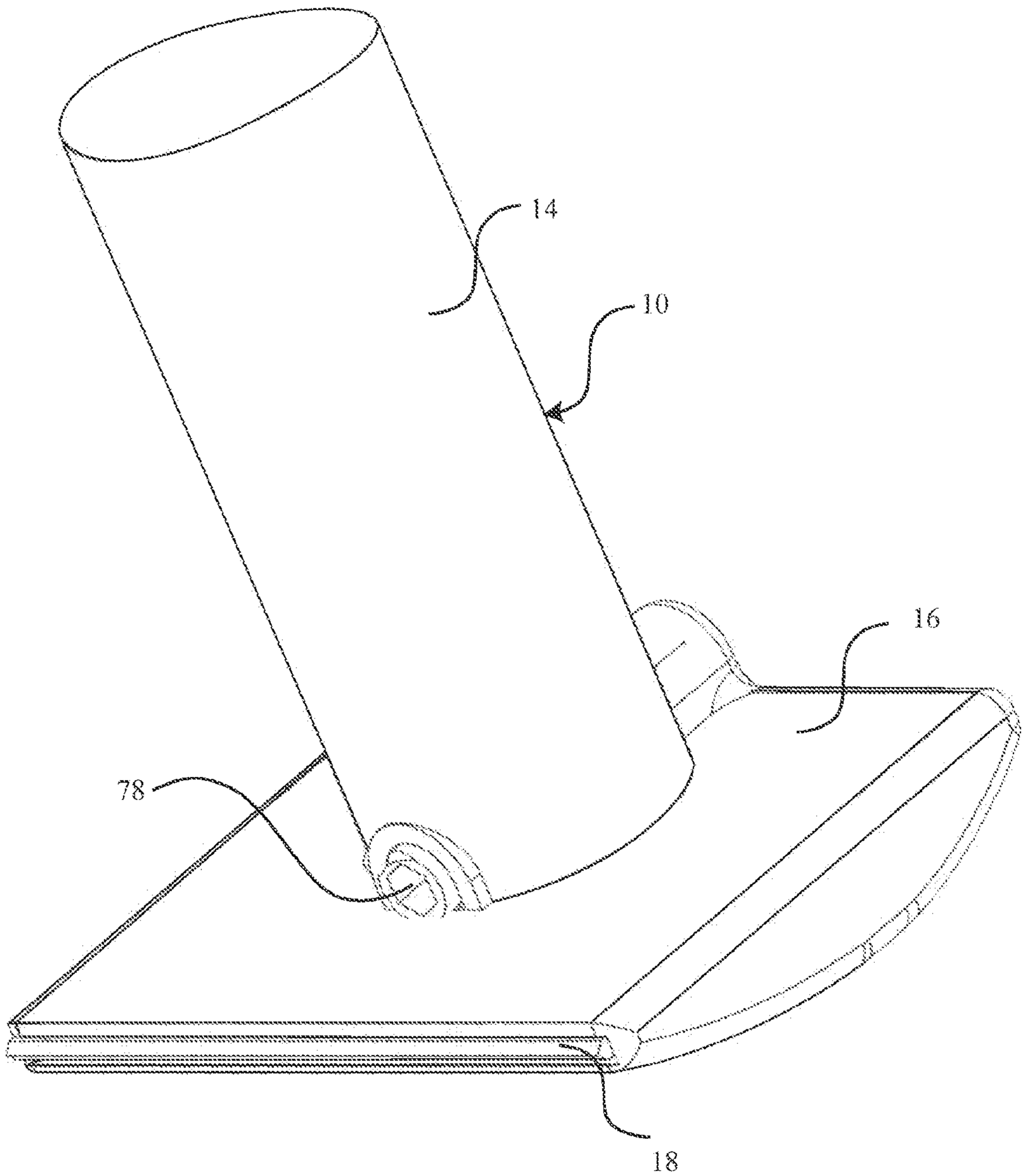


FIG 5A

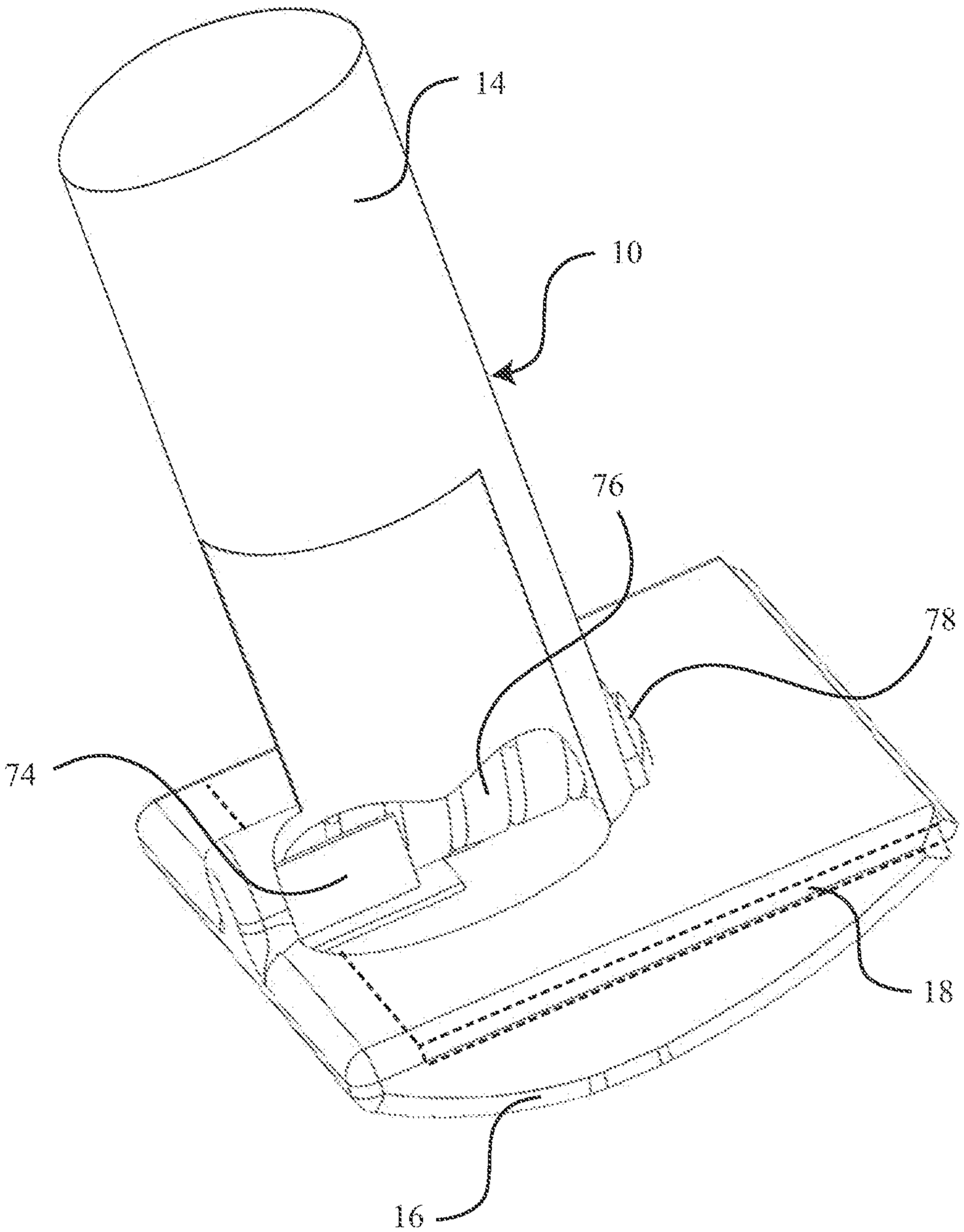


FIG 5B

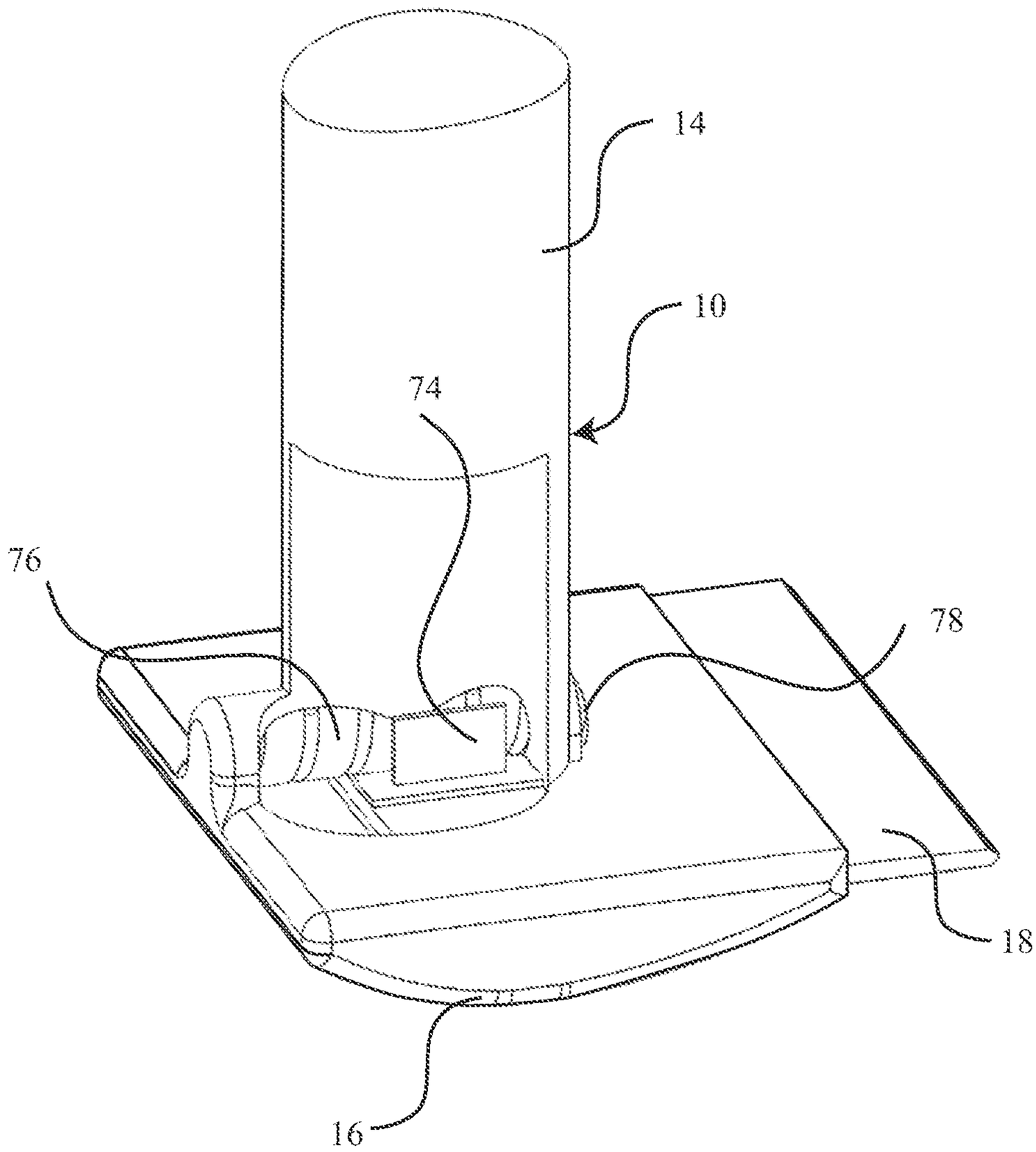


FIG 5C

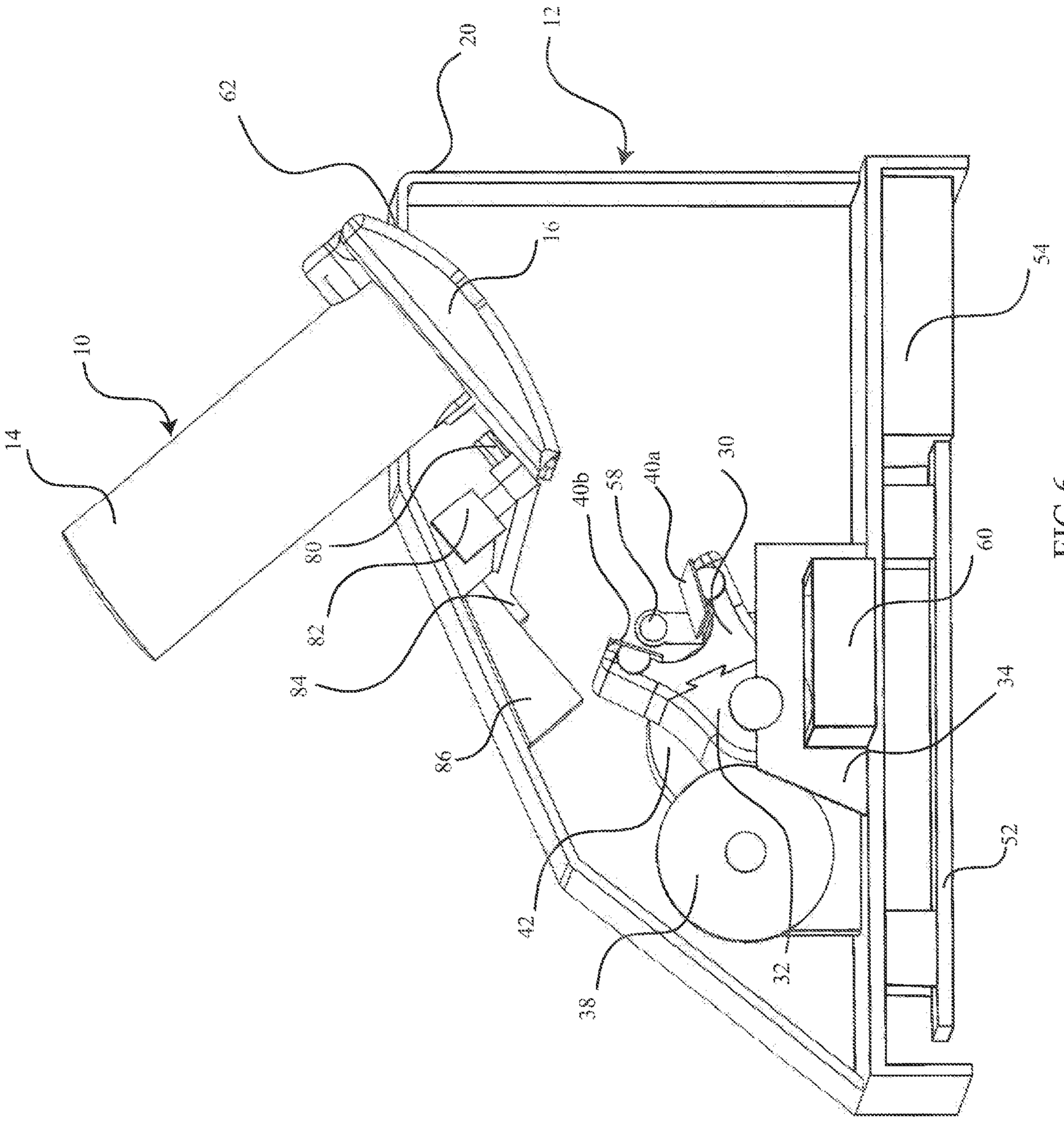


FIG 6

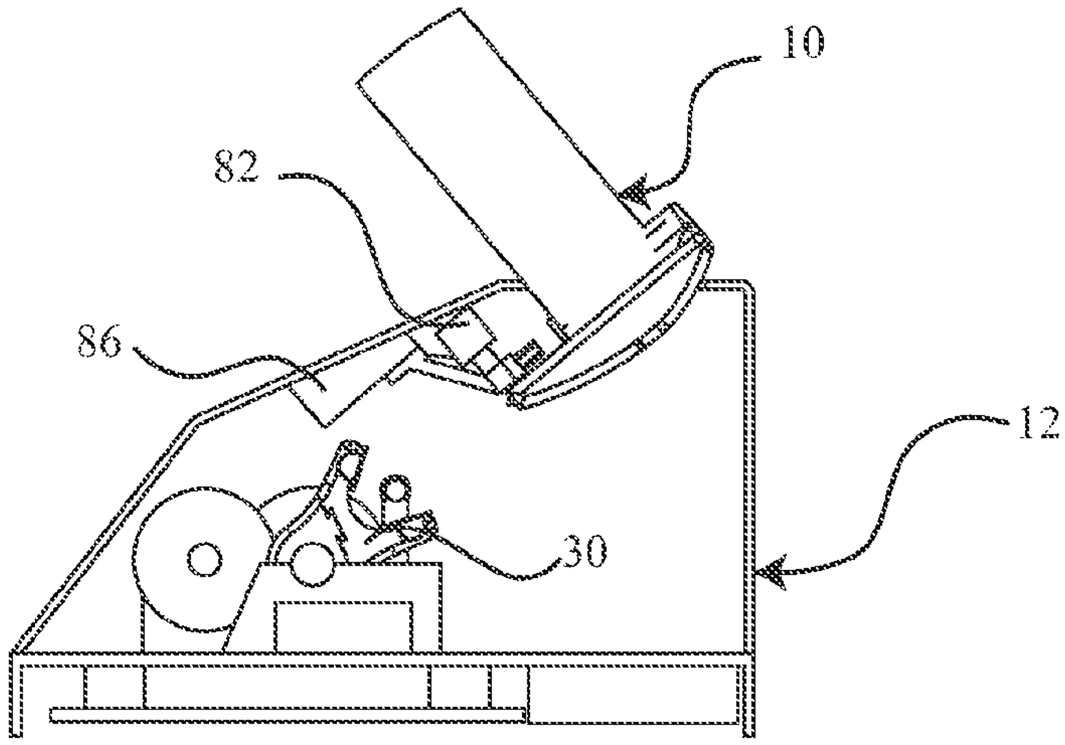


FIG 7A

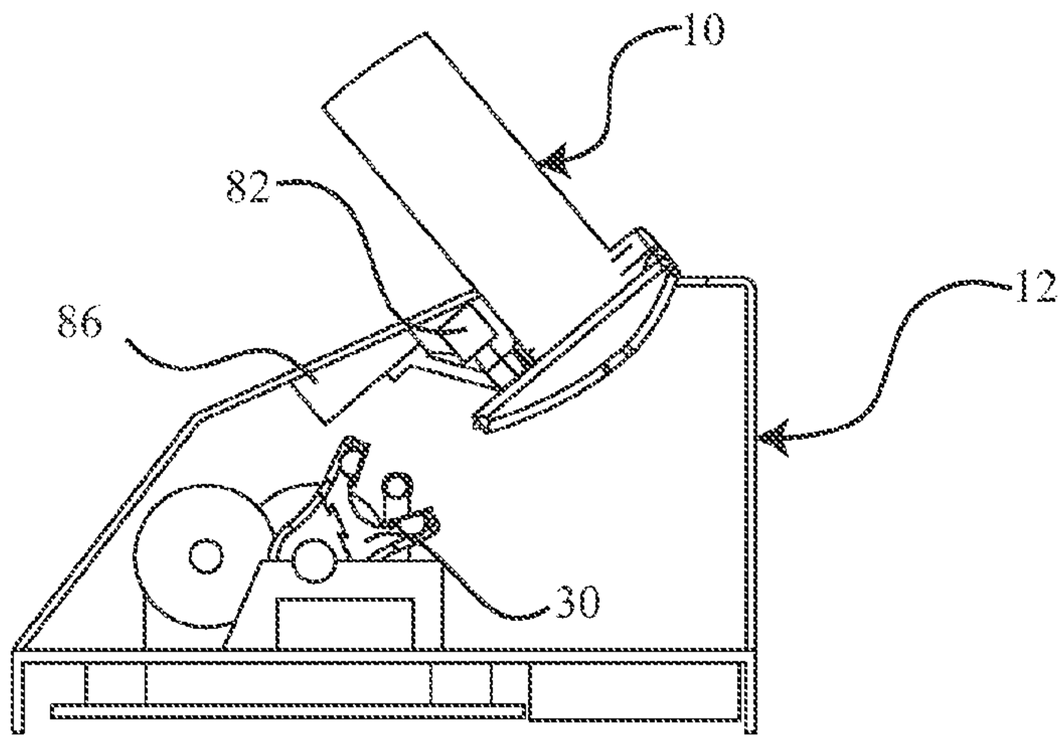


FIG 7B

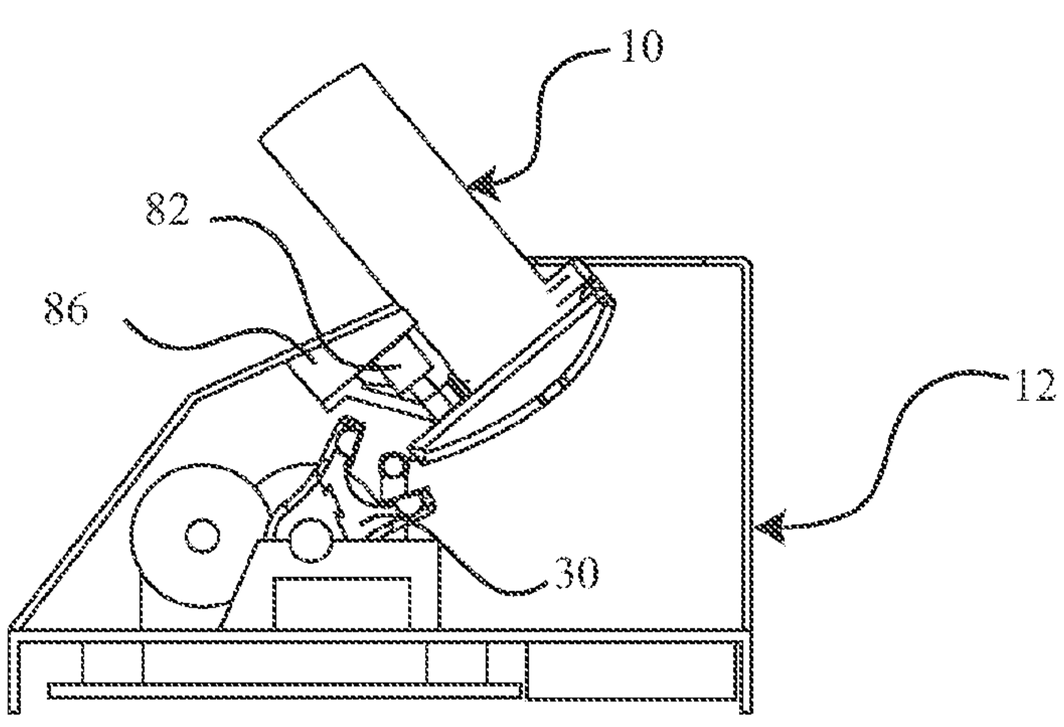


FIG 7C

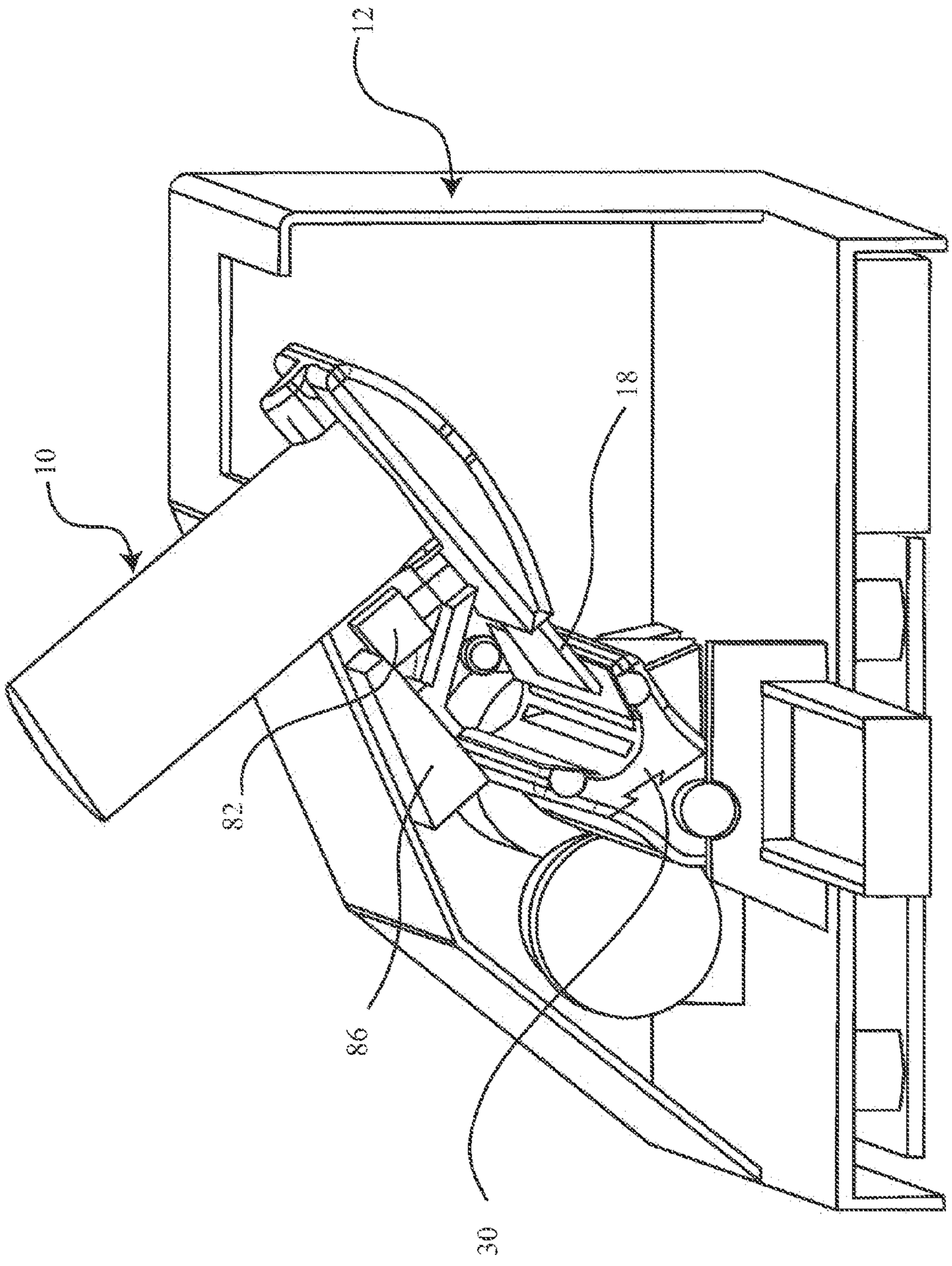


FIG 7D

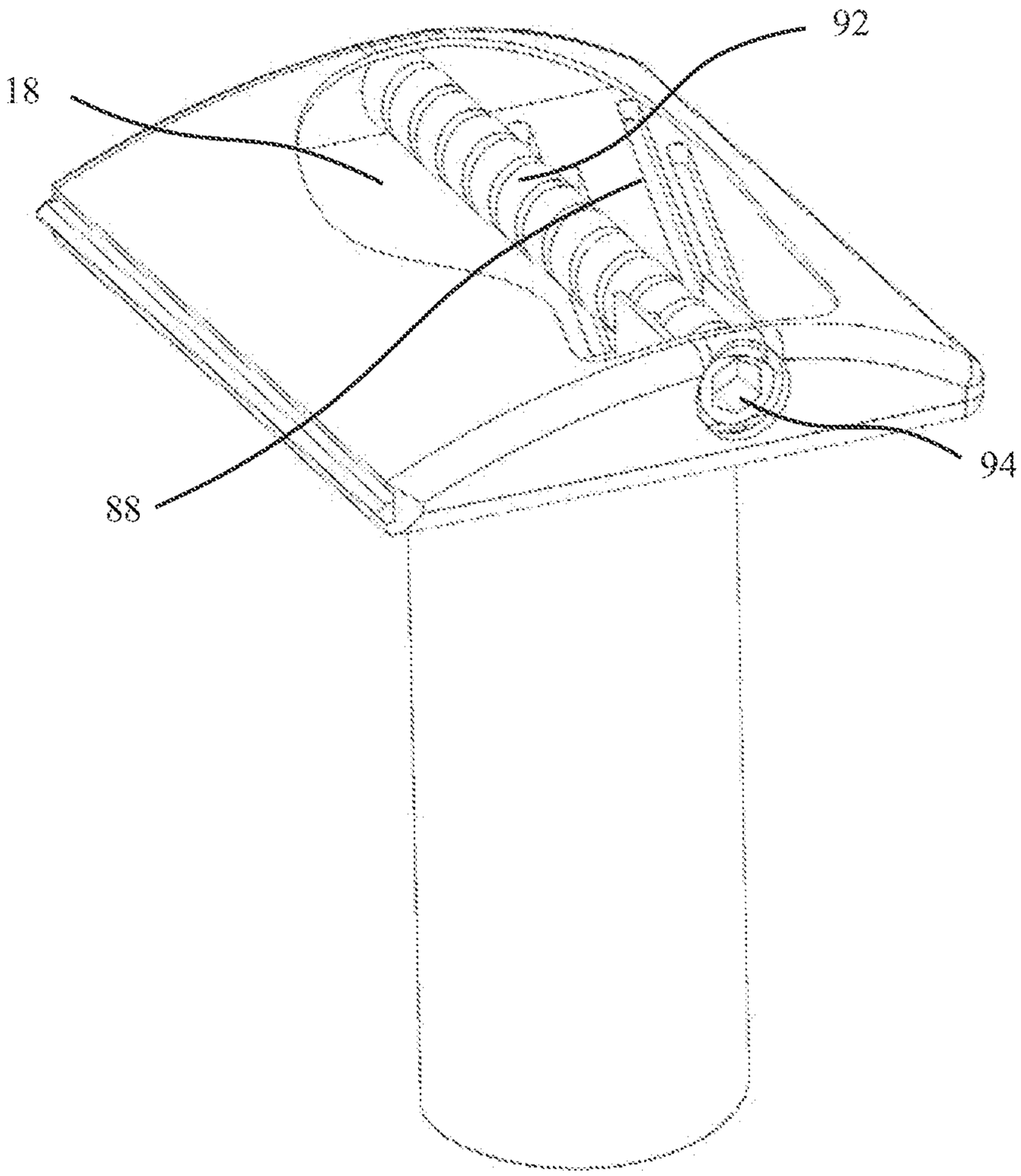
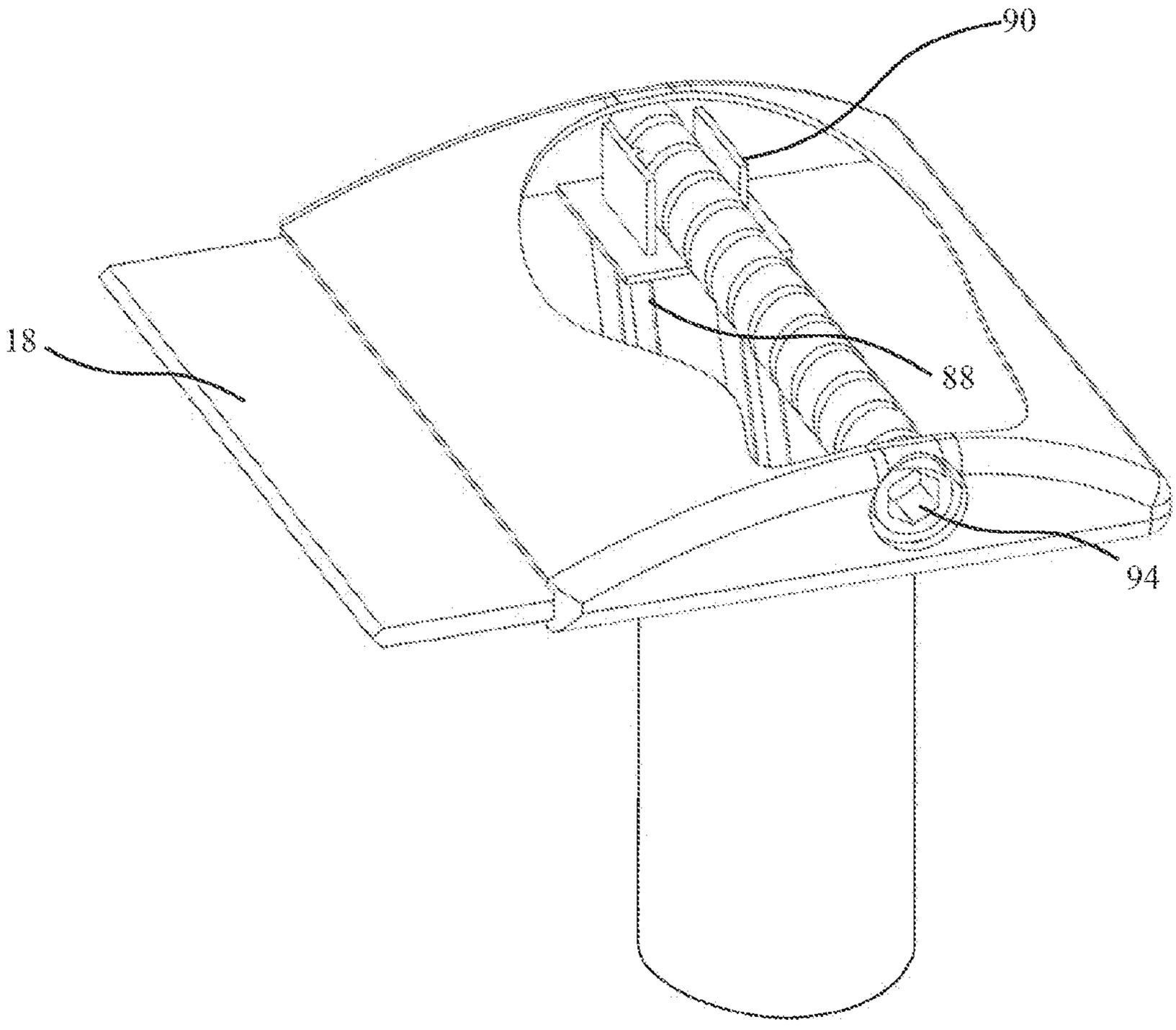


FIG 8A



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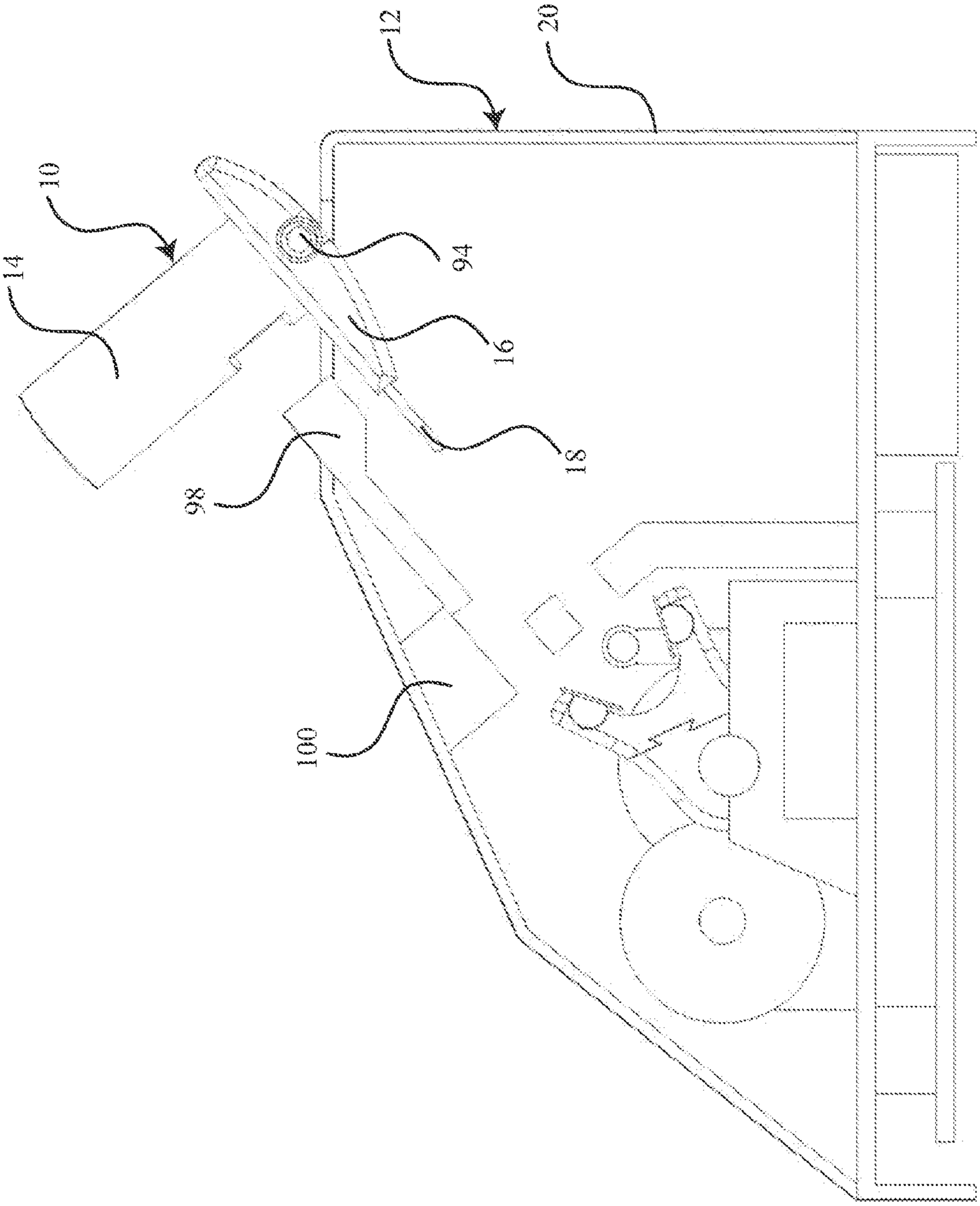

FIG 9A

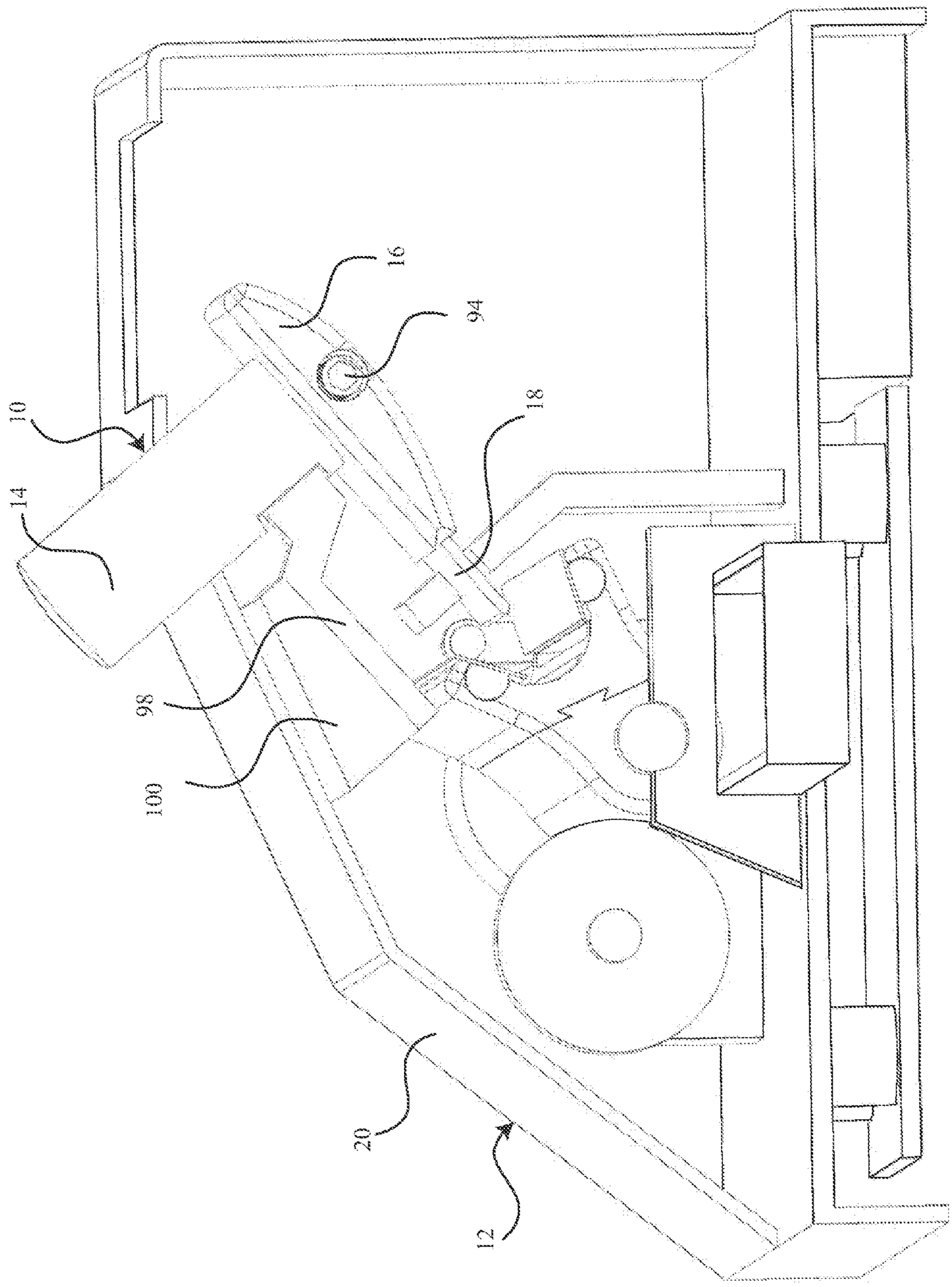

FIG 9B

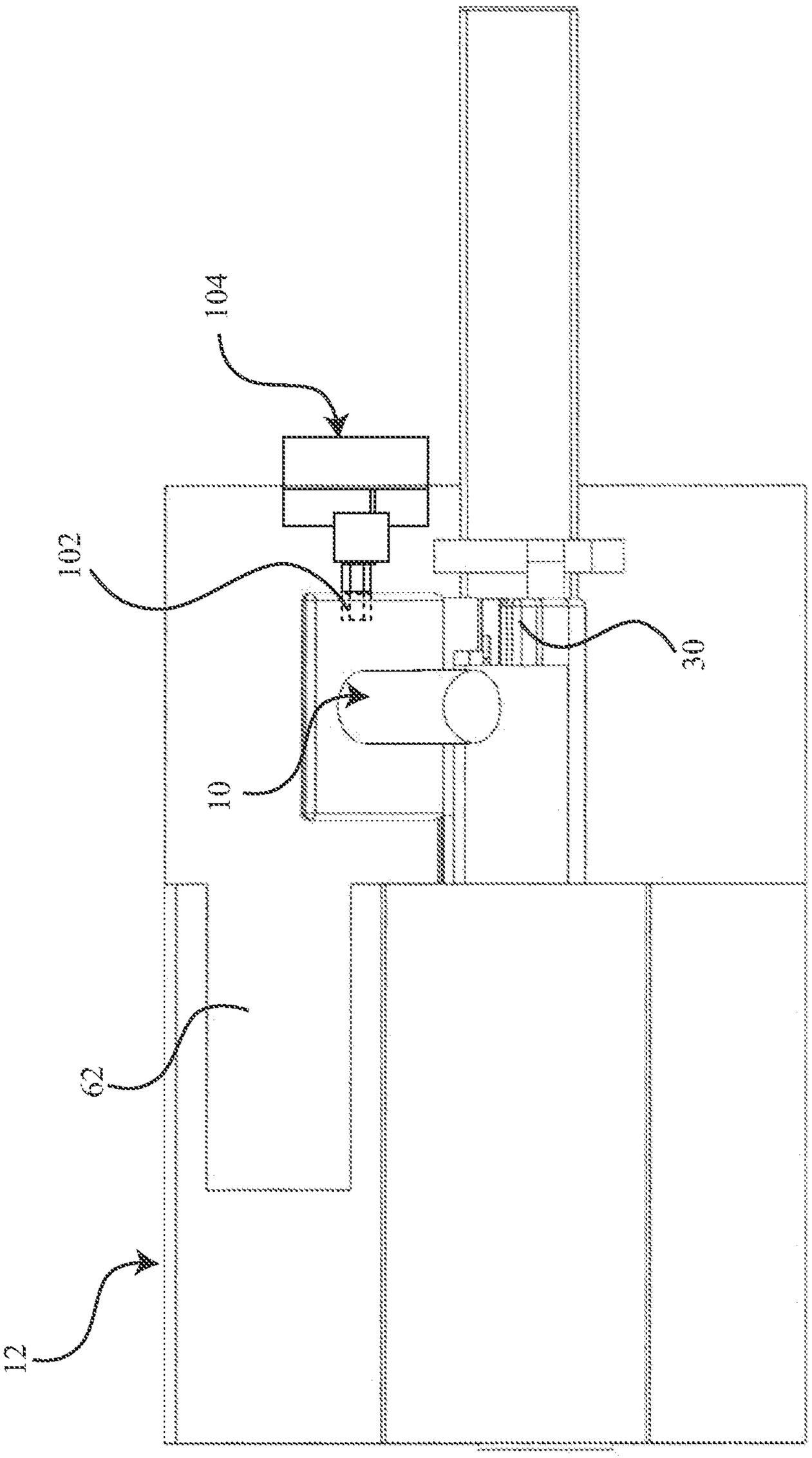

FIG 9C

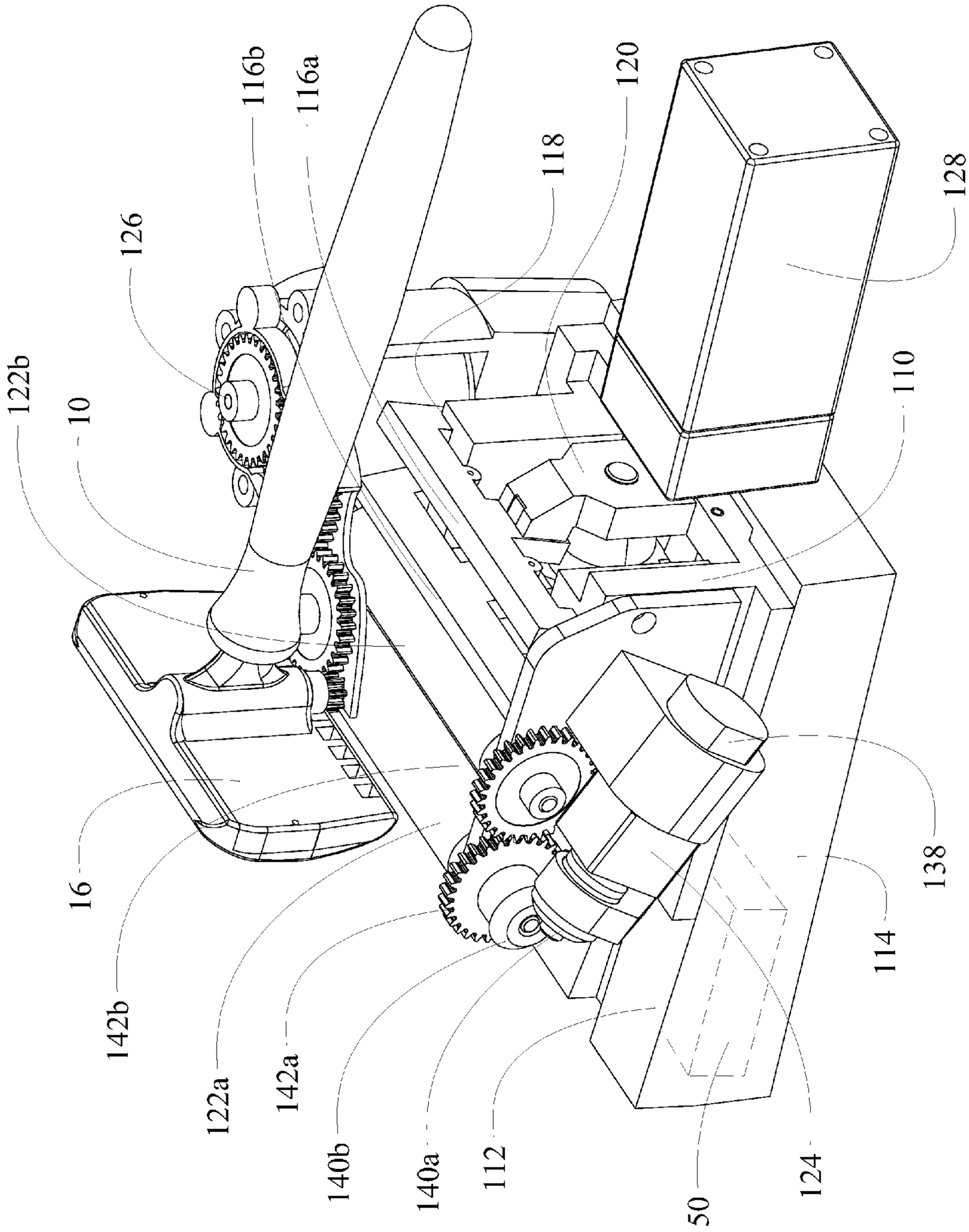
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FIG. 10

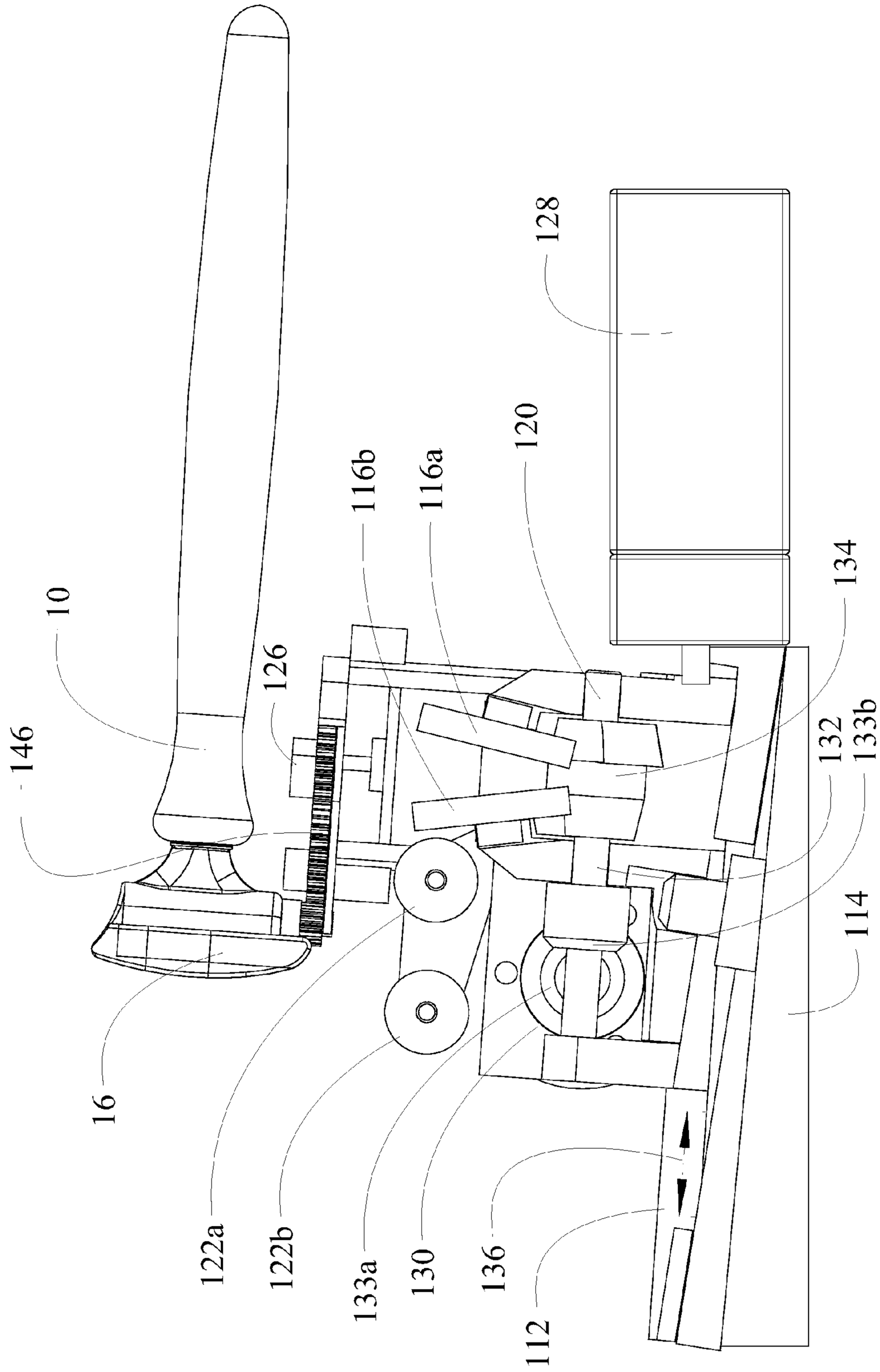
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FIG. 11

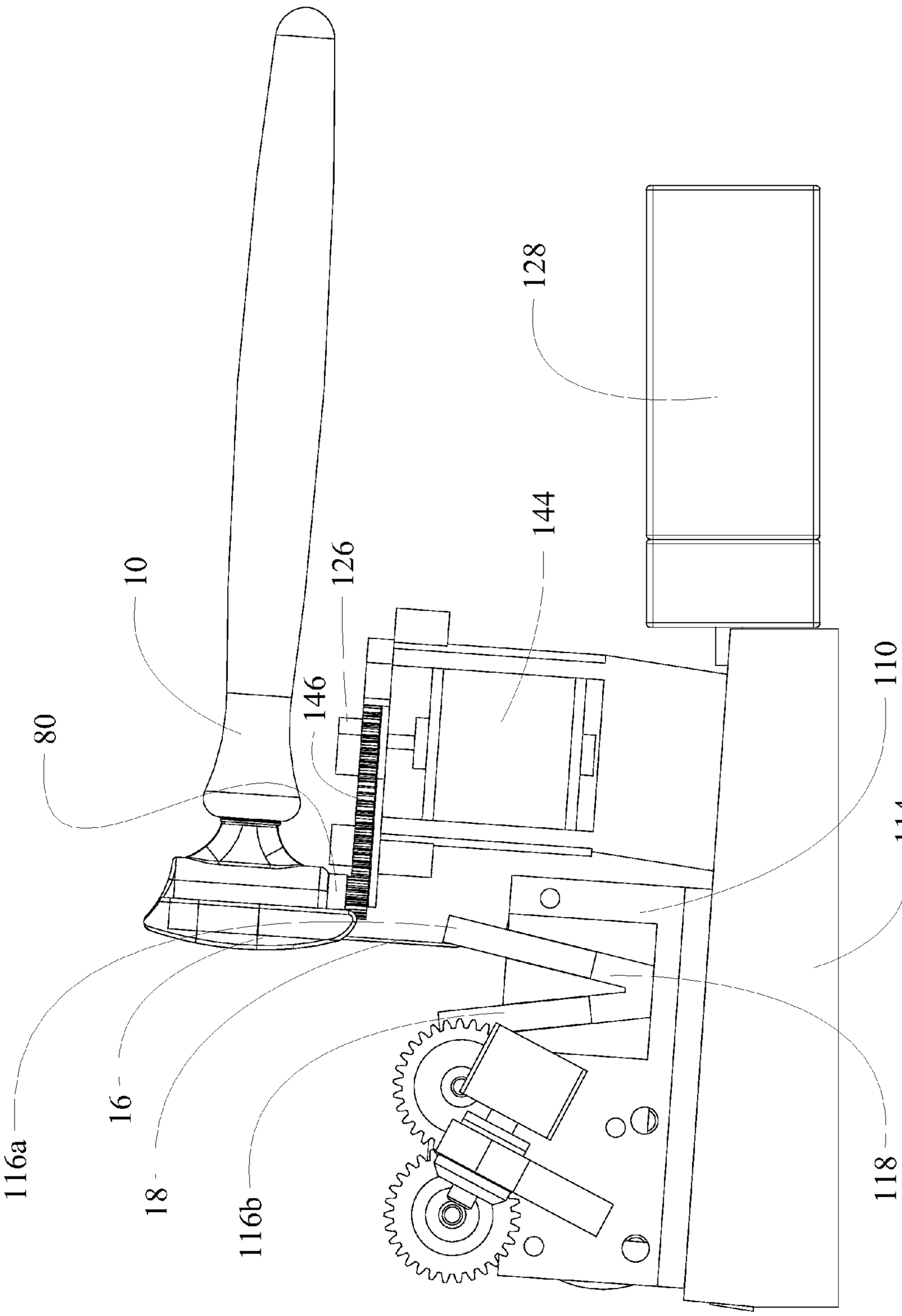


FIG. 12A

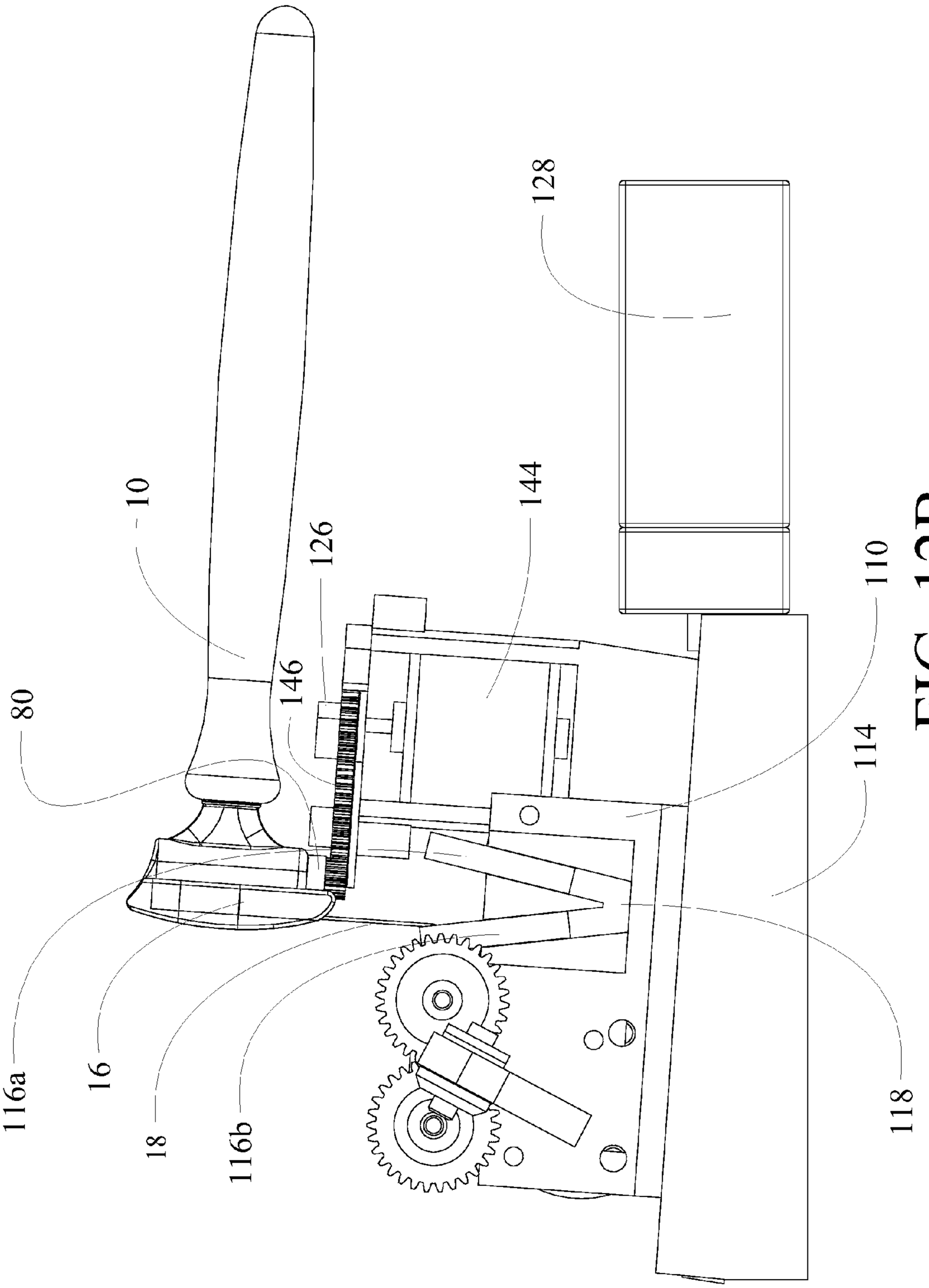


FIG. 12B

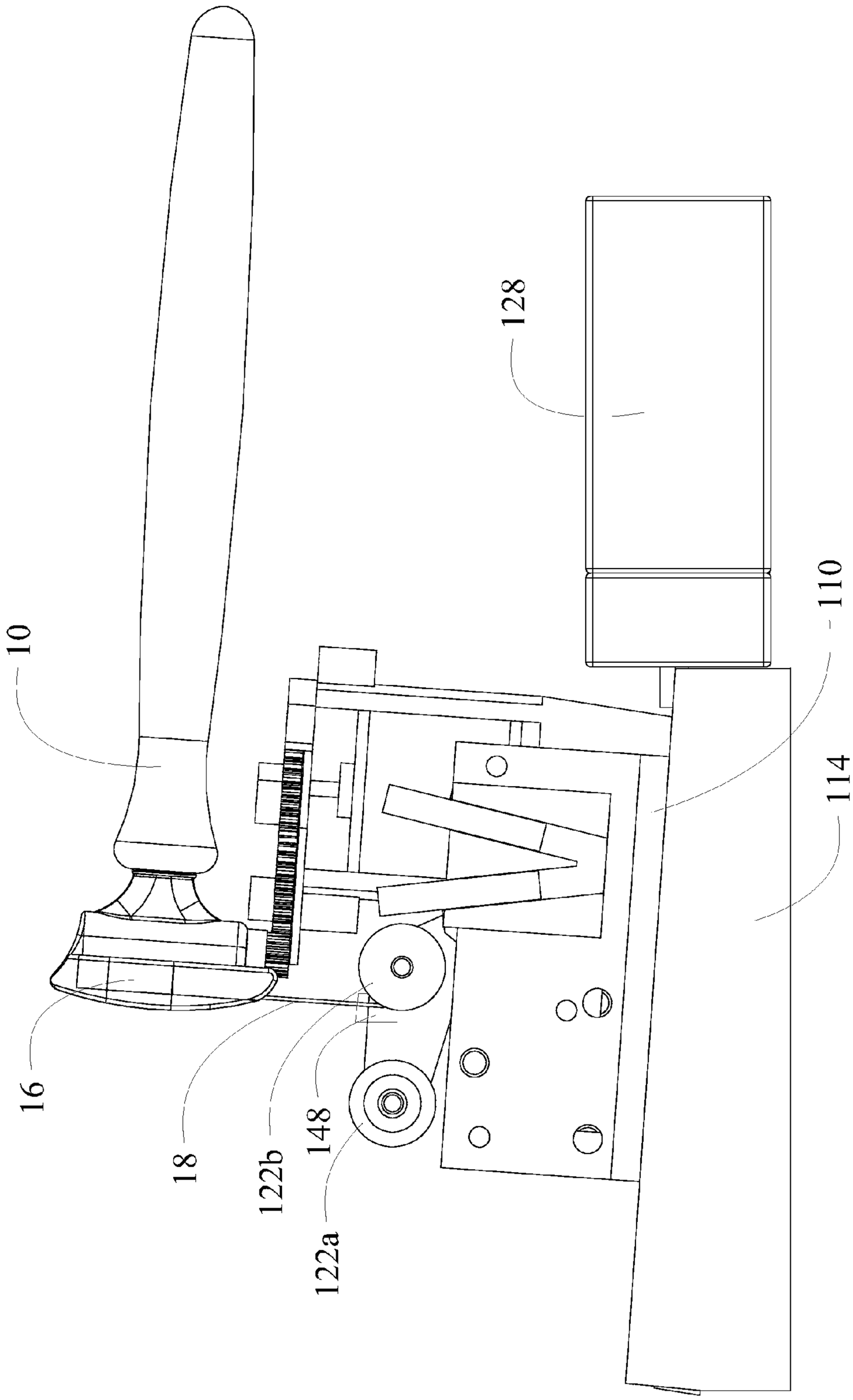


FIG. 13A

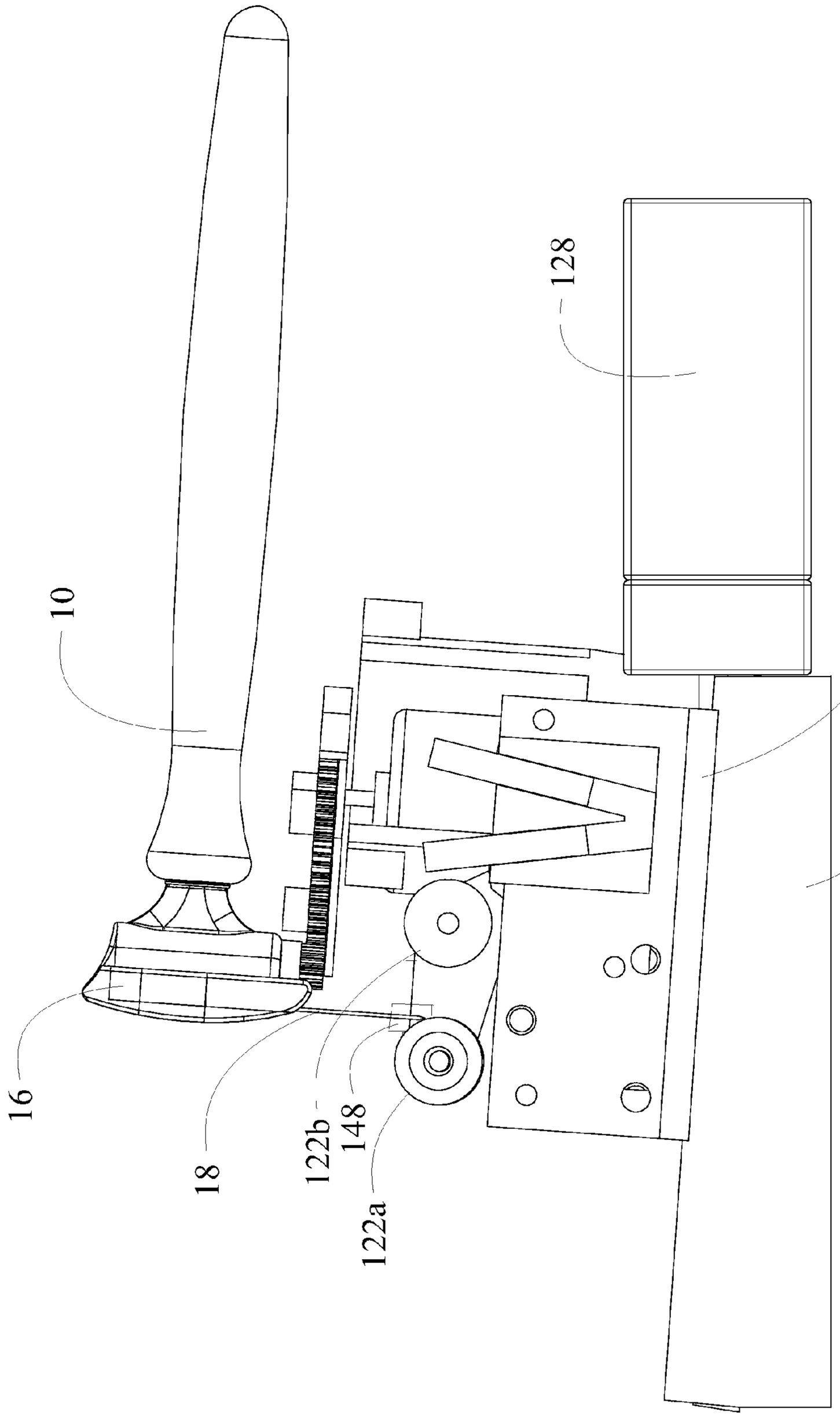


FIG. 13B

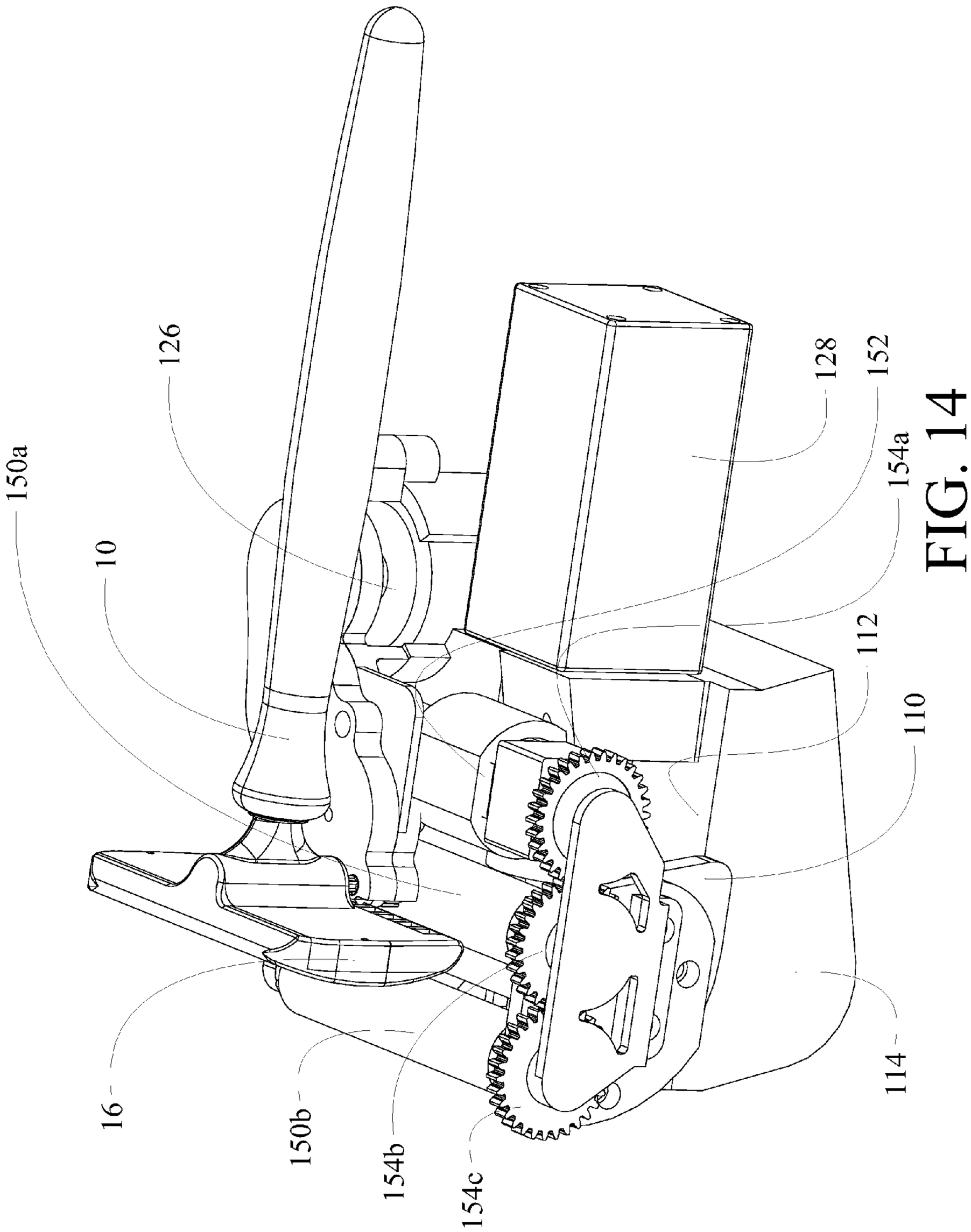


FIG. 14

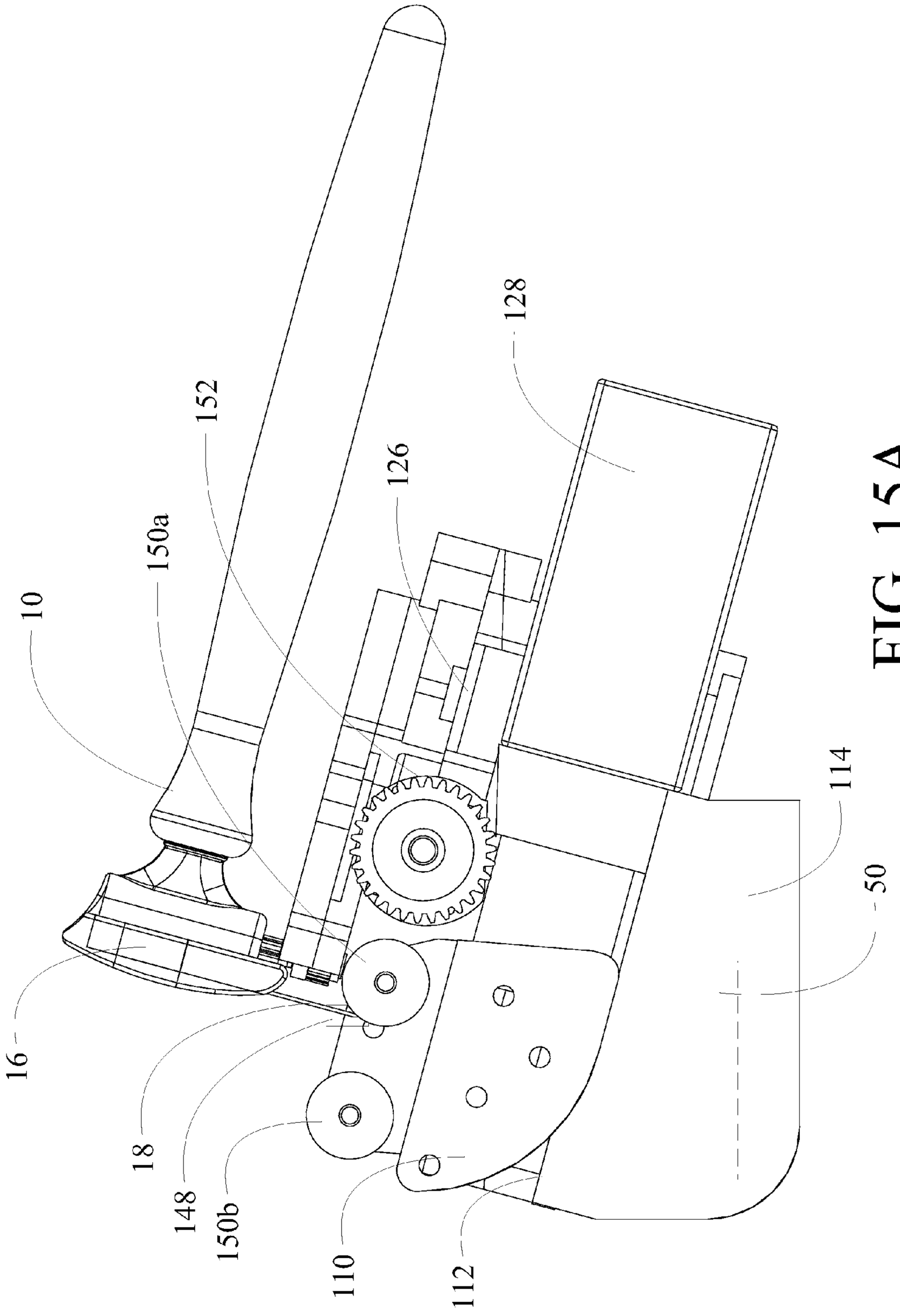


FIG. 15A

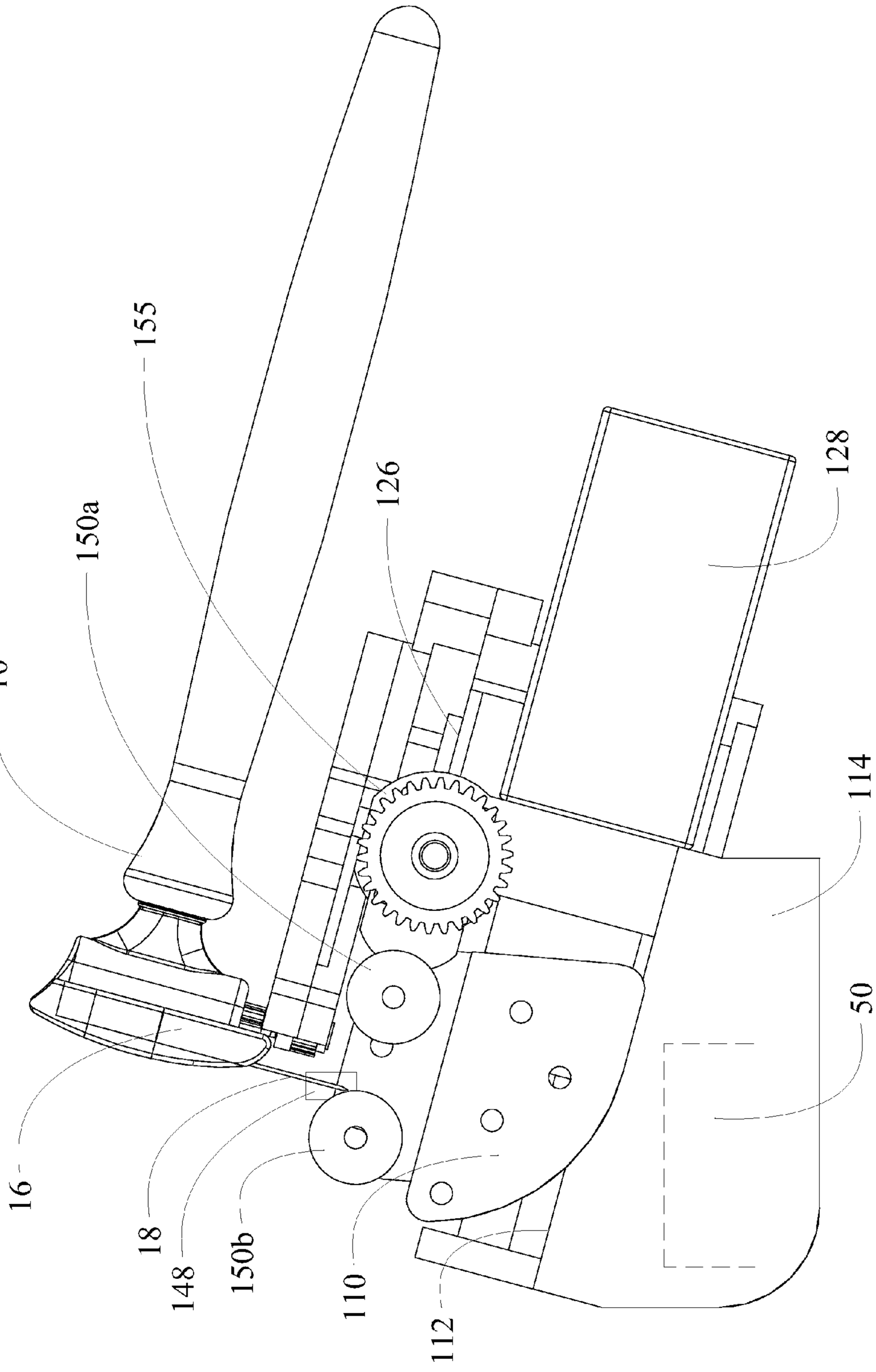
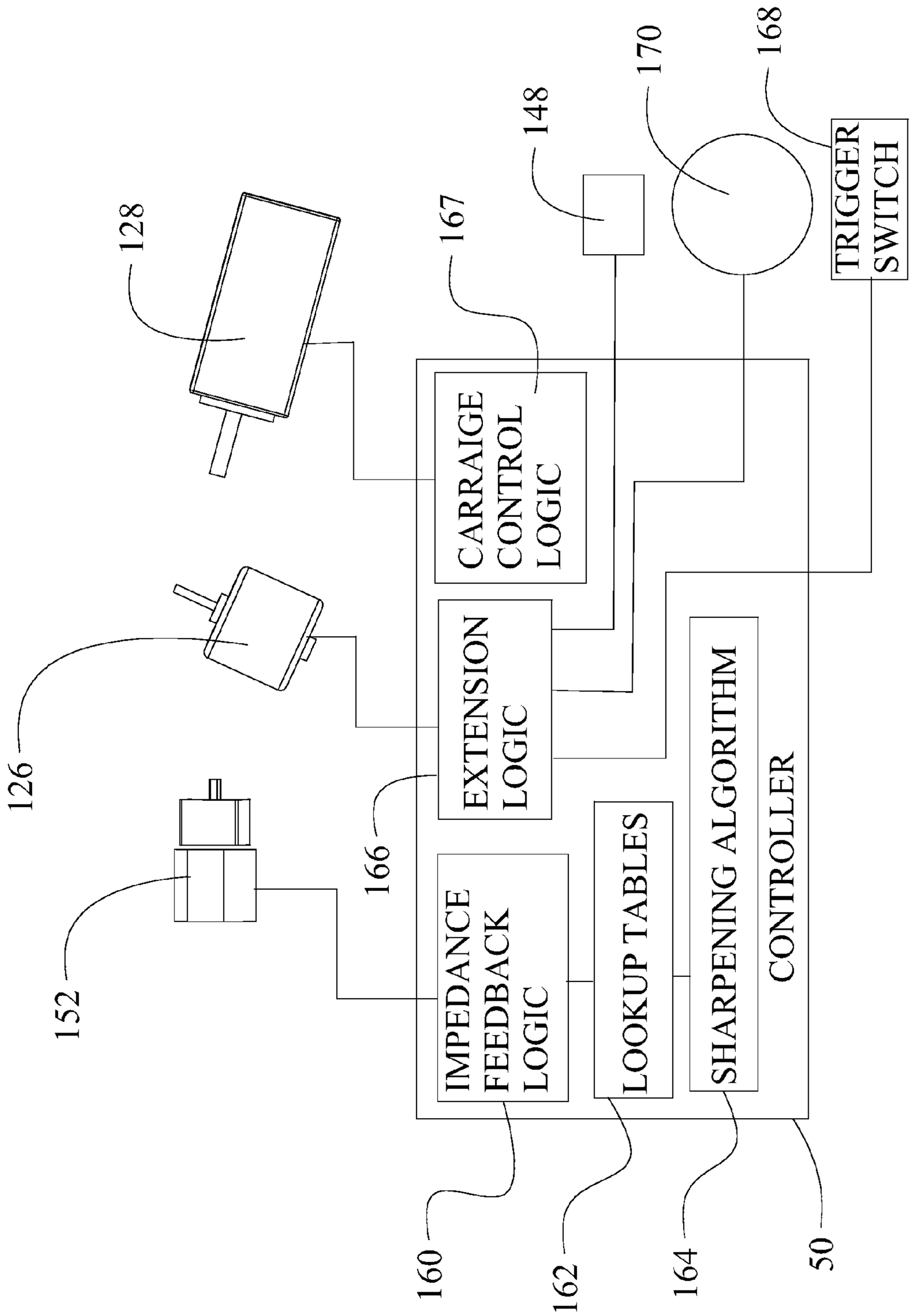


FIG. 15B


128
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TRIGGER SWITCH
CARRAIGE CONTROL LOGIC
EXTENSION LOGIC
IMPEDANCE FEEDBACK LOGIC
LOOKUP TABLES
SHARPENING ALGORITHM
CONTROLLER
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162
164
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FIG. 16

RAZOR SHARPENING SYSTEM

REFERENCES TO RELATED APPLICATIONS

This application is a continuation in part of copending application Ser. No. 13/413,582 filed on Mar. 6, 2012, the disclosure of which is incorporated herein by reference.

BACKGROUND INFORMATION

1. Field

Embodiments of the disclosure relate generally to the field of shaving razors and more particularly to a system incorporating a razor with an extendible blade received within an automated sharpening system having a blade extension armature, a reciprocating sharpening mandrel rotatable between two positions for sharpening both sides of the blade, a stropping system, a positioning sensor system, an ultraviolet disinfecting element and a magnetic blade polarization system.

2. Background

Shaving of facial and body hair is undertaken by both men and women to various degrees. Initially shaving was accomplished using a straight razor. However, the relative skill required to avoid cutting the skin during shaving made the straight razor an unattractive tool. Various devices including the safety razor and modern removable/replaceable/disposable head razor cartridges with multiple blades or entirely disposable razors have been invented to reduce the hazards of shaving while providing a reasonably safe and comfortable shave.

However, the advantages of the straight razor including the a rigid high quality steel construction for maintaining a sharp edge for an extremely clean and close shave, and the ability to resharpen the edge continuing long term use have not been duplicated in modern razor systems. Further, disposable razors are wasteful of both economic and natural resources and are by definition engineered to be operationally obsolescent within weeks if not days.

It is therefore desirable to provide a razor and sharpening system which maintains the efficiency and safety of modern disposable razor systems but also provides a higher quality shave with a long life reusable system.

SUMMARY

Embodiments disclosed herein provide a shaving system which includes a razor having a handle and a safety housing with a blade extendably received within the safety housing. An integrated sharpening system incorporates an armature receiving the razor, the armature being movable from a first position for attachment and extraction of the razor and a second position for sharpening of the blade. A sharpening mandrel is provided with a first sharpening surface for sharpening a first side of the blade and a second surface for sharpening of a second side of the blade. The sharpening mandrel is rotatable from a first position for engagement of the first sharpening surface to a second position for engagement of the second sharpening surface. The sharpening mandrel is laterally oscillated for sharpening of the blade. A controller is provided for positioning of the armature and sharpening mandrel.

The shaving system allows a method for sharpening a razor which is accomplished by engaging a razor having a blade extendibly mounted in a safety housing in an integrated sharpening system. The blade is then extended and a sharpening mandrel is rotated to a first position for engagement of a first side of the blade. The sharpening mandrel is then oscillated to hone the first side of the blade. The sharpening mandrel is then rotated to a second position for engagement of the opposite second side of the blade and oscillated to hone the second side of the blade. The blade is then retracted and the razor is disengaged from the integrated sharpening system.

The features, functions, and advantages that have been discussed can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective partial section side view of a first embodiment of the razor and integrated sharpening system;

FIG. **2** is a perspective partial section side view of the embodiment of FIG. **1** with the sharpening mandrel and mandrel holder removed for display of remaining components;

FIGS. **3**A and **3**B are side section views of the embodiment of FIG. **1** with the razor in preparation for insertion and inserted into the integrated sharpening system;

FIGS. **4**A-**4**E are simplified schematic representations of the operating components of the embodiment of FIG. **1** showing the sequence of operation for blade sharpening;

FIG. **5**A is a perspective view of a second embodiment of the razor;

FIG. **5**B is a perspective partial section view of the razor embodiment of FIG. **5**A with the blade retracted;

FIG. **5**C is a perspective partial section view of the razor embodiment of FIG. **5**A with the blade extended;

FIG. **6** is a perspective partial section side view of a second embodiment of the integrated sharpening system for use with the razor of FIGS. **5**A and **5**B;

FIGS. **7**A-**7**D are side section views of the operating components of the embodiment of FIG. **6** showing the sequence of operation for blade sharpening;

FIG. **8**A is a top partial section perspective view of a third embodiment of the razor with the blade in a retracted position;

FIG. **8**B is a top partial section perspective view of a third embodiment of the razor with the blade in an extended position;

FIG. **9**A is a perspective partial section side view of a third embodiment of the integrated sharpening system for use with the razor of FIGS. **8**A and **8**B;

FIG. **9**B is a perspective partial section view of the embodiment of FIG. **9**A with the razor moved into the sharpening position and the blade extended;

FIG. **9**C is a top view of the embodiment of FIG. **9**A;

FIG. **10** is an isometric view of an embodiment providing an alternative honing structure with stropping wheels for finer edge finish;

FIG. **11** is a side view of the embodiment of FIG. **10** partially sectioned to demonstrate the components in the honing and stropping assemblies;

FIG. **12**A is a side view of the embodiment of FIG. **11** with elements removed showing the honing assembly engaging the blade for honing on a first side;

FIG. **12**B is a side view with elements removed showing the honing assembly engaging the blade for honing on a second side;

FIG. **13**A is a side view showing the stropping assembly engaging the blade for stropping on a first side;

FIG. **13**B is a side view showing the stropping assembly engaging the blade for stropping on a second side;

FIG. **14** is an isometric view of yet another embodiment providing combined honing and stropping in adjacent wheels;

FIG. **15**A is a side view of the embodiment of FIG. **14** with elements removed showing the honing assembly engaging the blade for honing on a first side;

FIG. **15**B is a side view with elements removed showing the honing assembly engaging the blade for honing on a second side; and,

FIG. **16** is a block diagram of an exemplary control system for implementation of blade sharpening.

DETAILED DESCRIPTION

Embodiments disclosed herein provide a self sharpening razor system incorporating a razor carrying a high quality steel blade, for example stainless or carbon steel with minimum Rockweel hardness of approximately 58, which is extendible from a safety housing for sharpening and an integrated sharpening system in an enclosure receiving the razor. The integrated sharpening system provides a blade extension armature for positioning the razor and/or blade, a reciprocating sharpening mandrel rotatable between two positions for sharpening both sides of the blade, a proximity sensor positioning system an ultraviolet disinfecting element and a magnetic blade polarization system with an internal controller for automated sharpening and preparation of the razor for use.

Referring to the drawings, FIG. **1** shows a first exemplary embodiment for a razor **10** and integrated sharpening system **12**. The razor **10** employs a handle **14** which carries a safety housing **16** enclosing a blade **18** which is extendible from the housing. The integrated sharpening system **12** is housed in a case **20** A blade extension armature **22**, which removably receives the razor housing and blade on an engagement post **24**, is movable from a first position (shown) for insertion of the razor to a second adjustable position for sharpening of the blade indicated by arrow **26** (as will be described in greater detail with respect to FIGS. **4**A-**4**C). A translation motor **28** supports the blade extension armature **22** and provides the desired reciprocating motion.

Contained within the case **20** is a sharpening mandrel **30** which is removably carried by a mandrel holder **32**. The holder is supported on saddles **34** (shown in greater detail in FIG. **2**) for rotation, represented by arrow **36**, about a longitudinal axis by a mandrel rotation motor **38**. The sharpening mandrel **30** incorporates two sharpening surfaces which for the embodiment shown are two sharpening pads **40***a* and **40***b* on angularly displaced faces which are positioned for sharpening of opposing sides of the blade **18** of the razor through the rotation of the sharpening mandrel. For an example embodiment, the sharpening pads are an injection molded plastic with a thin coating of Cubic Boron Nitride (CBN) dust or diamond dust bonded to its surface to act as a sharpening media. The estimated size of the sharpening dust particles will be between 0.25-2 microns in size. For the embodiment shown, the open angular segment of the mandrel subtends approximately 75° of arc. An oscillating motor **42** attached to the mandrel holder **32** provides lateral oscillation of the sharpening mandrel **30** and associated sharpening pads **40***a* and **40***b* as indicated by arrow **44**. In the example embodiment, a voice coil motor is employed but alternative motor types may be used in other embodiments.

While described with respect to the drawings as sharpening pads with abrasive surfaces, the pads may also employ materials for stropping the blade to provide blade alignment and sharpness without actual removal of material as in sharpening. In alternative embodiments, the sharpening pads, **40***a* and **40***b* may be replaceable with interchangeable abrasive and stropping elements.

An ultraviolet (UV) lighting system having a lower head **46***a* and an upper head **46***b* is provided in the case as a sanitizing element. The heads are positioned such that the extended blade **18** and end portion of the safety housing **16** passes between the lower and upper head exposing all contact points on the razor to the UV light for optimal elimination of microbial contaminants. An electromagnet **48** positioned in the case adjacent the extended blade enhances corrosion resistance by alignment of the metal ions in a plane of the shaving edge of the blade with an electromagnetic field after the sharpening cycle as described subsequently.

Control of the integrated sharpening system is accomplished with a controller **50** which may incorporate a microprocessor or other control logic and associated control circuitry on a printed circuit board **52** mounted within the case. Power for the motors and controller is provided by a battery **54**, or in alternative embodiments a standard 110 v AC connection stepped down with an appropriate transformer circuit to 6 volts for either direct use or battery charging. Associated with the controller **50** is a Radio Frequency Identification (RFID) reader **56** which is positioned in the case **20** to read an RFID tag associated with each razor housing **16**. Identification of the razor being sharpened allows the controller to specifically tailor the sharpening operation to that razor blade taking into account age and wear and may also provide the ability to notify the user when the useful life of a blade has been exceeded based on stored data as well as track product warranty related usage. proximity sensor positioning system **58**, which may employ a photo cell "detection eye", other optical sensor, a capacitive or inductive position sensor, is connected to the controller **50** and positioned adjacent the sharpening mandrel **30** for precise location of the edge of the blade **18** for accurate positioning and sharpening. Measurements by the proximity sensor positioning system of the blade position/length prior to sharpening and after sharpening may be stored by the controller for use in blade wear data cataloging. A second proximity sensor positioning system may also be used to accurately reposition the razor blade relative to the to safety housing **16** account for blade wear caused by sharpening.

A removable debris catch tray **60** is positioned in the case **20** under the sharpening mandrel to catch and retain debris such as hair and grinding dust accumulated from sharpening of the blades. Slots in the sharpening mandrel **30** allow metal debris to fall into the tray **60**. The case **20** includes a frame providing the mounting features required to securely fasten all internal components with accuracy. This sub-frame may be made from injection molded ABS plastic or die cast zinc material.

As shown in FIGS. **3**A and **3**B, the safety housing **16** of the razor **10** is inserted through aperture **62** to be received on engagement post **24**. For the embodiment shown the engagement post employs a spring loaded detent ball to engage a receiving cavity on the blade **18** in the safety housing **16** of the razor **10**. In the inserted position as shown in FIG. **3**B, the razor is then ready for the sharpening operation. As shown in simplified schematic form for the first embodiment in FIGS. **4**A-**4**D, the razor is aligned with the engagement post **24** (FIG. **4**A) and pressed onto the post (FIG. **4**B). For this embodiment of the razor safety housing and blade the blade **18** is frictionally engaged between resilient back elements **64** and a front plate **66** of the housing **16** (as best seen in FIG. **4**D). Engagement arms **68** are received through slots in the front plate and, when the razor safety housing **16** is urged onto

the engagement post **24**, urge the resilient back element away from the rear surface of the blade **18** releasing the frictional engagement of the blade in the housing. An array of spaced ridges or dimples **70** may be employed to enhance the frictional engagement to additionally secure the blade and to provide fixed increments for length positioning of the blade upon reinsertion into the housing.

The safety housing for various embodiments may be made from injection molded Acrylonitrile-Butadiene-Styrene (ABS) plastic or Die Cast aluminum with an anodized finish. If made from aluminum the resilient back elements may be spring steel component to act as the locking feature for the guard. If made from plastic the resilient elements can be molded directly into the part as a "living hinge" type design. For the example embodiment, the razor blade is a steel alloy in the 200 series with post hardening treatment to achieve a Rockwell hardness of approx. 58-62. The edge of the blade is sharpened to an included angle of 15 degrees. The blade will include the ridges **70** as a stamped feature. The thickness of the blade is between 0.035"-0.045"

Extension armature **22** is then translated downward by translation motor **28** extending the blade **18** which is secured by the engagement post **24**. Depending securing elements **72** on the arms **68** (which are shown as smooth for mere frictional engagement but may be hooked or otherwise mating indexed to the front plate **66** of the housing) prevent downward translation of the housing. Translation motor **28** is controlled by the controller **50** to move the extension armature **22** for positioning of the blade **18** as determined by the proximity sensor positioning system **58**. The blade edge is placed at a predetermined position for correct angular contact by the sharpening pad **40***a* on the sharpening mandrel **30** which has been angularly positioned by the mandrel rotation motor **38** (shown in FIGS. **1** and **2**) for contact with the blade. The sharpening mandrel **30** is then reciprocated laterally along the blade edge by the by the oscillating motor **42** (as seen in FIGS. **1** and **2**) honing a first side of the blade edge. The sharpening mandrel **30** is then rotated by the mandrel rotation motor **38** to angularly position the second sharpening pad **40***b* on an opposite contact plane with the blade. The sharpening mandrel **30** is then reciprocated laterally along the blade edge by the by the oscillating motor **42** honing a second side of the blade edge. Adjustment of the extended length of the blade between the honing of the two sides of the edge may be accomplished, if required, by the translation motor moving the extension armature as directed by the controller based on the blade location detected by the proximity sensor positioning system.

Upon completion of the sharpening process, the translation motor **28** moves the extension armature **22** upward to retract the blade **18** into the safety housing **16** with calculated alignment with the spaced array of dimples **70** for optimal shave angle of the blade relative to the housing. The translation motor **28** may be a stepper motor, piezo electric motor or similar precision motor allowing precise control by the controller for the retracted length to accommodate the overall length reduction in the blade due to the sharpening procedure. Removal of the razor from the engagement post **24** returns the resilient arms **64** into contact with the blade **18** to frictionally secure the blade within the safety housing **16**. Additionally with use of a stepper motor or motor having similar accuracy as the mandrel rotation motor **38**, the controller may adjust the rotation angles of the mandrel **30** in combination with the blade position using the translation motor **28** such that the blade is moved for spaced contact slightly outward on pads **40***a* and **40***b* from where the blade touched in the last sharpening session. Once the entire pad has been used, the logic resets the blade onto the inside portion of the sharpening pads **40***a* and **40***b* closest to the vertex of the mandrel and the sequence starts over again.

A second exemplary embodiment of the razor **10** is shown in FIGS. **5**A through **5**C. As with the first embodiment, the blade **18** is extendably retained with a safety housing **16**. However, the blade **18** incorporates a tracking dolly **74** which is engaged by a jack screw **76**. The screw **76** incorporates a hex bore **78** for drive engagement. Rotation of the screw **76** drives the tracking dolly **74** which extends or retracts the blade into the housing. In alternative embodiments, a gear rack machined into the upper surface of the blade **18** may engage the jack screw for extension and retraction of the blade.

A second exemplary embodiment of integrated sharpening system **20** to accommodate the razor second embodiment is shown in FIG. **6** with components in common with FIGS. **1**-**3**C carrying the same element numbers. The razor **10** is inserted into the aperture **62** in case **20** and rotating engagement post **80** is received within the hex bore **78** which may incorporate a spring loaded detent ball to be received within a detent in the hex bore to secure the razor into the case. A drive motor **82** with appropriate drive train rotates the rotating engagement post **80** and the engagement post **80** with drive motor **82** and drive train are mounted to a translation armature **84**. A translation motor **86** moves the translation armature **84** to position the safety housing **16** within the case as required by the controller **50**. While not shown in FIG. **6**, the UV lighting system, RFID reader and electromagnetic polarization system as described with respect to FIGS. **1** and **2** may be employed in the second embodiment.

As shown in FIGS. **7**A-**7**C, the safety housing **16** of the razor **10** is inserted through aperture **62** and hex bore **76** is aligned with the engagement post **80** (FIG. **7**A) and pressed onto the post (FIG. **7**B). Translation armature **84** is then translated downward by translation motor **86** (FIG. **7**C). Drive motor **82** is then operated to rotate rotating engagement post **80** and **76** screw to drive gear rack **74** extending the blade **18** (FIG. **7**D). Translation motor **86** and drive motor **82** are controlled by the controller **50** for positioning of the blade **18** as determined by the proximity sensor positioning system **58**. The blade edge is placed at a predetermined position for correct angular contact by the sharpening pad **40***a* on the sharpening mandrel **30** which has been angularly positioned by the mandrel rotation motor **38** (shown in FIGS. **1** and **2**) for contact with the blade. The sharpening mandrel **30** is then reciprocated laterally along the blade edge by the by the oscillating motor **42** (as seen in FIGS. **1** and **2**) honing a first side of the blade edge. The sharpening mandrel **30** is then rotated by the mandrel rotation motor **38** to angularly position the second sharpening pad **40***b* on an opposite contact plane with the blade. The sharpening mandrel **30** is then reciprocated laterally along the blade edge by the oscillating motor **42** honing a second side of the blade edge. Adjustment of the extended length of the blade between the honing of the two sides of the edge may be accomplished, if required, by the drive motor **82** turning rotating engagement post **80** and attached screw **74** as directed by the controller based on the blade location detected by the proximity sensor positioning system.

Upon completion of the sharpening process, the drive motor **82** turns the rotating engagement post **80** and screw **74** to retract the blade. The drive motor **28** may be a stepper motor or similar precision motor allowing precise control by the controller for the retracted length to accommodate the overall length reduction in the blade due to the sharpening procedure. The controller then moves the translation arma-

ture **84** with translation motor **86** upward to return the razor to the initial position for extraction from the case.

A third exemplary embodiment of the razor **10** is shown in FIGS. **8**A and **8**B. As with the first and second embodiments, the blade **18** is extendably retained with a safety housing **16**. Similar to the second embodiment, the blade **18** incorporates angled tracks **88** which are engaged by pins extending from a tracking dolly **90** carried on a jack screw **92**. The jack screw **92** incorporates a hex bore **94**. Rotation of the screw drives the tracking dolly along the screw laterally within the safety housing from a retracted position as shown in FIG. **8**A, extending the blade from the housing as the tracking dolly drives the angled tracks as shown in FIG. **8**B. An engagement recess **96** is provided in the handle **14** of the razor.

A third exemplary embodiment of integrated sharpening system **20** to accommodate the razor third embodiment is shown in FIGS. **9**A, **9**B and **9**C with components in common with FIGS. **1-3**C again carrying the same element numbers. The razor **10** is inserted into the aperture **62** in case **20** and engagement recess **96** is removably attached to a translation armature **98**. A translating motor **100** moves the translation armature to position the razor in the case **20** as shown in FIG. **9**B. As shown in FIG. **9**C, a rotating engagement post **102** (shown in hidden line) is received within the hex bore **94** which may incorporate a spring loaded detent ball to be received within a detent in the hex bore to secure the razor into the case. A drive motor **104** with appropriate drive train turns the rotating engagement post **102**. While not shown in FIGS. **9**A-**9**C, the RFID reader and electromagnetic polarization system as described with respect to FIGS. **1** and **2** may be employed in the third embodiment.

Operation of the third embodiment is substantially similar to the operation of the second embodiment with positioning of the safety housing within the case by the translating motor **100** and extension and retraction of the blade with the drive motor **104**.

An additional embodiment of the integrated sharping system for use with a razor embodiment as shown and described with respect to FIGS. **5**A-C is shown in FIG. **10**. An alternative to the sharpening mandrel **30** of FIGS. **7**A-D is provided by a carriage **110** movable on a rail base **112** in the case **20** (only a bottom plate **114** of the case is shown for viewing of the other system components). For sharpening of the blade **18** in razor **10**, carriage **110** supports two honing elements, honing plates **116***a* and **116***b* which are reciprocated in guides **118** on the carriage **110** by a honing motor and cam system **120** to be described in greater detail subsequently. To provide a fine finish on the blade **18**, the carriage **110** additionally supports two stropping rollers **122***a* and **122***b* rotationally driven by a stropping motor and gear assembly **124** to be described in greater detail subsequently. As with the embodiments described previously, razor **10** is held in the case **114** and the blade **18** extended through a blade extension motor assembly **126** to be described in greater detail subsequently. Positioning of the carriage **110** on the rail base **112** for engagement of the blade **18** by a selected one of the honing plates or stropping rollers is accomplished with a carriage motor **128**. As with prior embodiments, the controller **50** as previously described (shown schematically in FIG. **10** in an electronics bay in case bottom plate **114**) is employed for operation of the motors and motor assemblies.

As shown in detail in FIG. **11** (with blade extension motor assembly **126** and the side plate of the carriage **110** removed for clarity), honing plates **116***a* and **116***b* are driven for vertically reciprocating motion in guides **118** by honing motor and cam system **120**. System **120** incorporates a gear head motor **130** driving a shaft **132** through bevel gears **133***a* and **133***b* to rotate a cam **134** which engages the honing plates **116***a* and **116***b* causing them to reciprocate in the guides. Carriage **110** is translated laterally as indicated by arrow **136** to engage the desired honing plate **116***a* or **116***b* with opposing sides of the extended blade **18**.

Stropping wheels **122***a* and **122***b* are supported in the carriage **110** and, as with the honing plates, are placed into engagement with the blade **18** by lateral translation of the carriage **110**. For translation between the honing processes and stropping processes, the blade **18** may be retracted to clear the top extremities of the honing and stropping elements. The stropping motor gear assembly **124**, seen in detail in FIG. **10**, incorporates a drive motor **138** rotating bevel gears **140***a* and **140***b* to rotate stropping gear **142***a*, connected to stropping roller **122***a*, which in turn rotates stropping gear **142***b*, connected to the stropping roller **122***b*, thereby rotating the stropping rollers in opposite directions.

As shown in FIG. **12**A (with motor **138** and the side of the carriage removed for clarity), with the razor **10** installed on the rotating engagement post **80**, the carriage motor **128** positions the carriage **110** for placement of the first honing plate **116***a* proximate the blade **18**. The blade **18** is extended from the safety housing **16** of razor **10** using the blade extension motor assembly **126** which incorporates a stepper motor **144** engaging a gear train **146** to rotate the rotating engagement post **80** for extension of the blade as previously described. Motor **130** drives the cam **134** (as best seen in FIG. **11**) to reciprocate the honing plate **116***a* to hone the blade **18** on a first side. A position sensor **148**, as an implementation of the proximity sensing system **58** previously described, is employed to sense position of the blade tip for positioning by blade extension motor assembly **126** and carriage positioning motor **128** to control engagement of the blade and honing plate.

Carriage **110** is then shifted by motor **128** to a position as shown in FIG. **12**B (with motor **138** and the side of the carriage removed for clarity) for sharpening a second side of the blade by engaging blade **18** with honing plate **116***b*. Motor **130** drives the cam **134** (as best seen in FIG. **11**) to reciprocate the honing plate **116***a* to hone the blade **18** on the second side.

For the embodiment shown, the blade **18** is then retracted and motor **128** repositions the carriage as shown in FIG. **13**A (with stropping motor and gear assembly **124** removed in its entirety and the side of the carriage removed for clarity) and the blade is again extended by blade extension motor assembly **126** to engage stropping roller **122***b* on the first side. Sensor **148** is again employed for relative positioning of the blade and carriage for proper engagement. The stropping motor and gear assembly **124** rotates stropping roller **122***b* as previously described with respect to FIG. **11** to strop the blade **18** on the first side.

Carriage **110** is then shifted by motor **128** to a position as shown in FIG. **13**B (with stropping motor and gear assembly **124** removed in its entirety and the side of the carriage removed for clarity) for stropping the second side of the blade by engaging blade **18** with stropping roller **122***a*. Sensor **148** is again employed for relative positioning of the blade and carriage for proper engagement. The stropping motor and gear assembly **124** rotates stropping roller **122***a* as previously described with respect to FIG. **11** to strop the blade **18** on the second side.

An additional alternative embodiment is shown in FIG. **14** wherein the honing elements are honing wheels **150***a* and **150***b*. As in the prior embodiment of FIG. **10**, the honing elements are supported on carriage **110** which now employs a reduced travel on rail base **112** driven by carriage motor **128**. A honing motor **152** rotates a first tooth gear **154***a* which

drives a second tooth gear **154***b* attached and rotating honing wheel **150***a*. A third tooth gear **154***c* engages the second tooth gear **154** and is attached to and rotates honing wheel **150***b*.

As shown in FIG. **15**A, (with the carriage side plate and tooth gears **154***b* and **154***c* removed for clarity), with the razor **10** installed on the rotating engagement post **80**, the carriage motor **128** positions the carriage **110** for placement of the first honing wheel **116***a* proximate the blade **18**. The blade **18** is extended from the safety housing **16** of razor **10** using the blade extension motor assembly **126** which incorporates a stepper motor engaging a gear train to rotate the rotating engagement post **80** for extension of the blade as previously described. Honing motor **152** drives the first and second tooth gears (as best seen in FIG. **14**) to rotate the honing roller **150***a* to hone the blade **18** on a first side. The position sensor **148** is employed to sense position of the blade tip for positioning by blade extension motor assembly **126** and carriage positioning motor **128** by controller **129** to control engagement of the blade and honing roller.

Carriage **110** is then shifted by motor **128** to a position as shown in FIG. **15**B (with the carriage side plate and tooth gears **154***b* and **154***c* removed for clarity) for sharpening a second side of the blade by engaging blade **18** with honing roller **150***b*. Honing motor **152** drives tooth gear **154***c* (through first and second tooth gears **154***a* and **154***b* as best seen in FIG. **14**) to rotate the honing roller **150***b* to hone the blade **18** on the second side.

For the described embodiment with stainless steel blades, the honing wheels incorporate cubic boron nitride (CBN) crystals of a desired grit level (between 4 k and 15 k) embedded in rubber cylinders formulated in such a manner that the CBN wears down at a predictable rate and, in the process reveals, a fresh layer of CBN as wear occurs during sharpening. CBN is used in this embodiment for sharpening a stainless steel blade. In this manner the blade will be both honed by the CBN and stropped by the rubber cylinder for edge straightening. For carbon steel blades the same rubber cylinders may be employed, but industrial diamonds will be embedded in place of the CBN.

Control of the sharpening system is accomplished using the controller **50** as shown in FIG. **16**. Positioning of the blade **18** for sharpening employs the extension motor assembly **126**, which may be implemented with motor **144** as a stepper motor, for extending the blade as specific number of counts counted by extension logic **166** associated with controller **50** and position is verified using sensor **148**. Motor **128** then positions the carriage **110** for engaging the blade with honing rollers **150***a* and **150***b* as described above using carriage control logic **167**. Using impedance feedback **160** from the honing motor **152** as the blade **18** is engaged and wheel wear data lookup tables **162** in a sharpening algorithm **164** in the controller, the desired blade angle is maintained (17 degrees for an example blade) as multiple sharpenings occur and the diameter of the wheel declines over time. For retraction of blade **18**, turns of extension motor assembly **126** are again counted by logic **166** and a trigger switch **168** allows for exact positioning of the retracted blade at the end of the process such that the position of the blade relative to the cartridge is the same every time regardless of the fact that the blade length is reduced over time. The user may adjust the exposure of the blade **18** relative to the cartridge **16** to set how aggressive or exposed the blade is for shaving. This is done by a variable dial **170** which provides input to the controller **50** in the base **114**, which in turn, adjusts logic **166** for the blade exposure.

Having now described various embodiments of the disclosure in detail as required by the patent statutes, those skilled in the art will recognize modifications and substitutions to the specific embodiments disclosed herein. Such modifications are within the scope and intent of the present disclosure as defined in the following claims.

What is claimed is:

1. A shaving system comprising:
a razor having a handle and a safety housing;
a blade extendably received within the safety housing;
an automated integrated sharpening system having
a blade extension motor assembly for extending the blade into position for sharpening;
a carriage supporting a first honing element for sharpening a first side of the blade and a second honing element for sharpening of a second side of the blade, said carriage laterally translatable from a first position for engagement of the first honing element and blade to a second position for engagement of the second honing element and blade; and,
a controller for positioning of the carriage.

2. The shaving system as defined in claim **1** wherein the first and second honing elements comprise a first and second honing plate, said honing plates reciprocated by a honing motor assembly for sharpening of the blade.

3. The shaving system as defined in claim **2** further comprising:
a first stropping roller for stropping the first side of the blade and a second stropping roller for stropping the second side of the blade, said stropping rollers supported by the carriage and said carriage further laterally translatable to a third position for engagement of the first stropping roller and the blade and a fourth position for engagement of the second stropping roller and the blade; and,
a stropping motor and gear assembly operationally engaging the first and second stropping rollers for rotation.

4. The shaving system as defined in claim **2** wherein the honing motor assembly comprises:
a motor engaging a shaft with first and second bevel gears;
a cam mounted to the shaft for rotation and engaging the honing plates for reciprocation.

5. The shaving system as defined in claim **2** further comprising a translation motor for positioning of the carriage at the first, second, third and fourth positions.

6. The shaving system as defined in claim **5** wherein the stropping motor and gear assembly comprises:
A second motor engaging a third and fourth bevel gears;
A first tooth gear mounted to the bevel gears and rotating the first stropping roller;
A second tooth gear engaging the first tooth gear and rotating the second stropping roller.

7. The shaving system as defined in claim **6** wherein the integrated sharpening system further comprises a position sensor to determine a position of the blade when extended.

8. The shaving system as defined in claim **1** wherein the first and second honing elements comprise first and second honing wheels, said honing wheels rotated by a honing motor assembly for sharpening of the blade.

9. The shaving system as defined in claim **8** wherein the honing motor assembly comprises:
a honing motor driving a first tooth gear,
a second tooth gear attached to the first honing wheel for rotation and engaged by the first tooth gear; and,
a third tooth gear attached to the second honing wheel for rotation and engaged by the second tooth gear.

10. The shaving system as defined in claim **9** wherein the first and second honing wheel comprise rubber cylinders with cubic boron nitride embedded therein.

11. The shaving system as defined in claim **1** wherein the razor safety housing incorporates a screw engaging a tracking dolly mounted to the blade, said screw rotatable for positioning the dolly and blade from a first retracted position to a second extended position and the integrated sharpening system further includes

an engagement post engaging the screw, and,

a drive motor attached to the engagement post for reversible rotation.

12. The shaving system as defined in claim **1** wherein the razor safety housing incorporates a screw engaging a tracking dolly received in angled slots on the blade, said screw rotatable for positioning the tracking dolly laterally in operable engagement with the angled slots to move the blade from a first retracted position to a second extended position and from the second extended position to the first retracted position;

the integrated sharpening system further including

an engagement post engaging the screw, and,

a drive motor attached to the engagement post for reversible rotation.

13. A method for sharpening a razor comprising:

engaging a razor having a blade extendibly mounted in a safety housing in an integrated sharpening system;

extending the blade;

translating a carriage to a first position for engagement of a first honing element on a first side of the blade;

operating the first honing element;

translating the carriage to a second position for engagement of a second honing element on a second side of the blade;

operating the second honing element;

retracting the blade; and,

disengaging the razor from the integrated sharpening system.

14. The method of claim **13** further comprising:

translating the carriage to a third position for engagement of a first stropping wheel with the first side of the blade; and,

translating the carriage to a fourth position for engagement of a second stropping wheel with the second side of the blade.

15. The method of claim **13** wherein the step of extending the blade comprises:

engaging a screw operably connected to the blade with a rotatable engagement post; and,

rotating the engagement post for extension of the blade.

16. The method of claim **13** wherein the step of extending the blade includes controlling the blade extension for contact of the first and second honing plates against the blade.

17. The method of claim **13** wherein the step of extending the blade includes controlling the blade extension for contact for contact of the first and second stropping wheels against the blade.

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